VOLUME 77 **POWER** NUMBER 3

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PHILIP W. SWAIN, *Managing Editor*
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Neck Out

● "Anybody will okay a platitude," said a wise medic recently. This editorial page proposes clear statements of opinions on matters that count, and thereby invites the axe. If you agree or disagree, write in, say why, and be brief, please.

Industry a Sump

● "Industry is a sump for heat," recently said D. Warren, of General Electric—certainly a better dumping ground than the river for power-skimmed heat. Installation, in process plants, of high-pressure turbines exhausting to process and dumping excess electricity into utility lines would add hundreds of thousands of *kilowatts* to utility capacity, and add *kilowatt-hours* at a fuel cost of one-tenth of a cent.

A pointed suggestion this. Two things halt its general application: The first is utility overcapacity, which will pass when business catches up. The second is utility hesitation to enter a new field of difficult negotiations. This also will pass as men learn how and gain courage.

Nothing for Nothing

● Economy is essential today, but blind "economy" is business suicide. "Spend nothing" orders are executive nonsense and can be proved such by the balance sheet.

In 1931, many plants tried this plan of living on nothing a year. They bought only when something broke. Under such headings as "oil," "coal," "repairs" they paid in 1932 *for what they didn't get in 1931*. And they ended 1932 with less money in the bank than if they had known how to plant pennies.

This is no plea for "spending." Not everything that is pretty and nice to have will pay out fast enough for present needs. But no business that expects to survive twelve months can get ahead by neglecting the many minor investments that will return their full cost in that period.

Unit Cost

● Every factory producing a single product should figure regularly the total power service cost per unit of that product. Management thinks, properly, in cents per yard of cloth, barrel of flour or ton of paper. The wise engineer will translate into this ultimate unit his combined expenditures for fuel, equipment and power-service supervision.

Coal in Tanks

● A small laundry power plant in the South is burning pulverized coal in a boiler furnace six miles from the nearest pulverizer. The product of a "central" pulverizing plant is delivered by truck in 50-lb. paper bags and dumped by hand into the feeder bin. Carrying this a step further, the old plan of delivering pulverized coal in special tank cars may be revived to give mining companies an outlet for screenings, to be pulverized at the mine and shipped to distant consumers. The idea certainly has its appeal, which will increase if and when fuel oil prices rise. It may develop commercial importance for certain mining companies and the smaller industrial power plants.

Operation

● In tune with the times, this number of *Power* stresses operation and maintenance. No. 1 is the International Harvester story, a superb example of what can be done by giving good boiler-room equipment a chance.

POWER Stands for

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of By-product Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

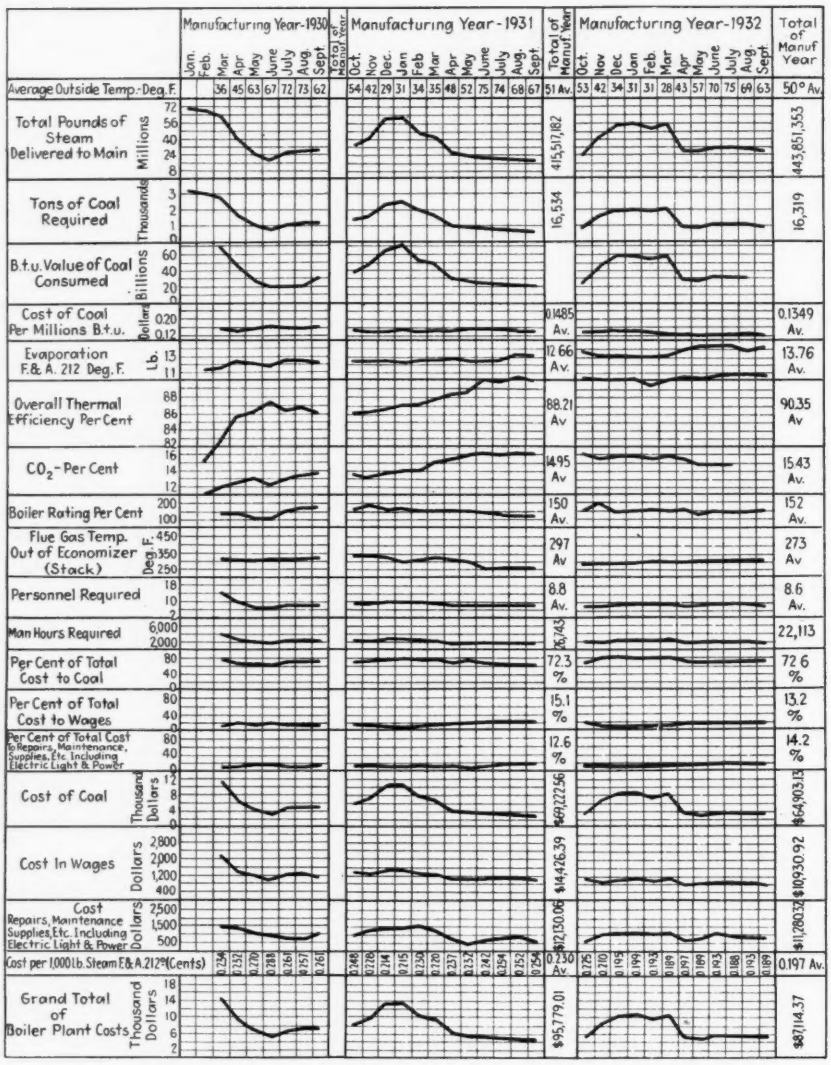

Manufacturing Year-1930
Manufacturing Year-1931
Manufacturing Year-1932
Total of Manuf Year
Jan. Feb. Mar Apr May June July Aug. Sept Oct. Nov Dec. Jan Feb Mar Apr May June July Aug. Sept
Average Outside Temp.-Deg. F.
Total Pounds of Steam Delivered to Main
Millions
Tons of Coal Required
Thousands
B.t.u. Value of Coal Consumed
Billions
Cost of Coal Per Millions B.t.u.
Dollars
Evaporation F.& A. 212 Deg. F.
Lb.
Overall Thermal Efficiency Per Cent
CO2 - Per Cent
Boiler Rating Per Cent
Flue Gas Temp. Out of Economizer (Stack)
Deg. F.
Personnel Required
Man Hours Required
Per Cent of Total Cost to Coal
Per Cent of Total Cost to Wages
Per Cent of Total Cost to Repairs, Maintenance, Supplies, Etc. Including Electric Light & Power
Cost of Coal
Thousand Dollars
Cost In Wages
Dollars
Cost Repairs, Maintenance Supplies, Etc. Including Electric Light & Power
Dollars
Cost per 1,000 lb. Steam E& A. 212°(Cents)
Grand Total of Boiler Plant Costs
Thousand Dollars

Fig. 1—Three years of operation on a single sheet.

90.3%

With the cooperation of of the International Harvester Company, *Power* here reports an outstanding example of boiler plant operation and tells how it was done

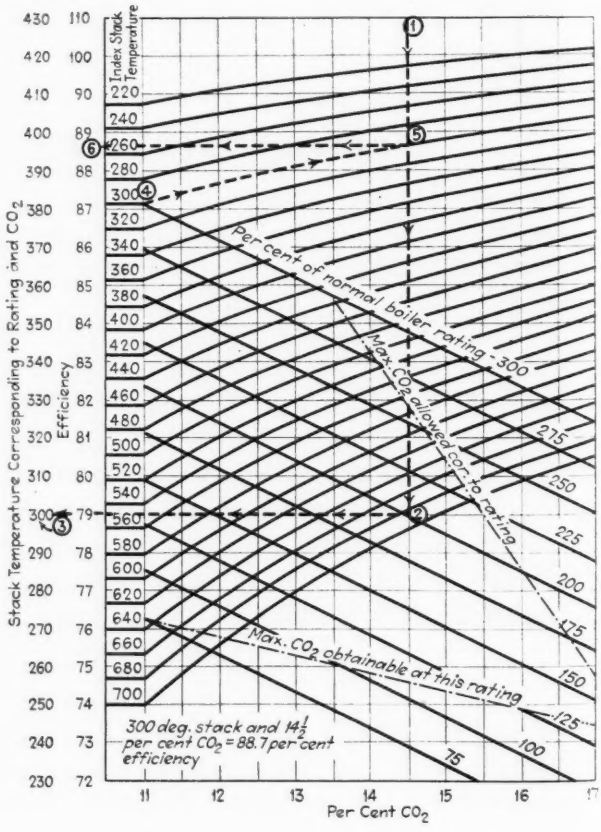


Fig. 2—This chart shows the operator: 1. Whether the CO_2 carried is within safe (slagging) limits. 2. Whether baffle leaks, air leaks or dirty tubes are raising flue temperature above best obtainable. Dotted line solution: (1), 14.5% CO_2; (2), 200% rating; (3), 300 deg. corresponding stock temp.; (4), 300 deg. index stack temp.; (5), 14.5% CO_2; (6), 88.7% efficiency.

THE facts here presented relate to the boiler plant of the International Harvester Company, Milwaukee Works. Efficiencies there maintained in daily operation are almost unbelievably high, yet first-hand contact with the plant, its operating personnel and methods, its system of records, checks and counter-checks, leaves no room for doubt as to the authenticity of the achievement here reported.

Power therefore presents, without apology or hesitation, a record of industrial plant boiler units that have maintained an average over-all efficiency of 90.3 per cent for a period of eighteen months starting June 1, 1931. This figure includes all standby loss. It does not include steam and electricity for auxiliary power. Inclusion of auxiliary power without credit for exhaust utilization (although it is actually used) still leaves an over-all boiler-room average efficiency of 89.0 per cent for the 18-month period.

Completed in May, 1930, the present International Harvester boiler plant is entirely standard in its equipment. It is unusual only in the care with which these standard elements have been assembled and in the extraordinary precautions taken to detect and remedy immediately every preventable loss, however small.

The record made by this relatively new plant is the more noticeable by contrast with its predecessor. The

BOILER EFFICIENCY

—An Average for 16 Months

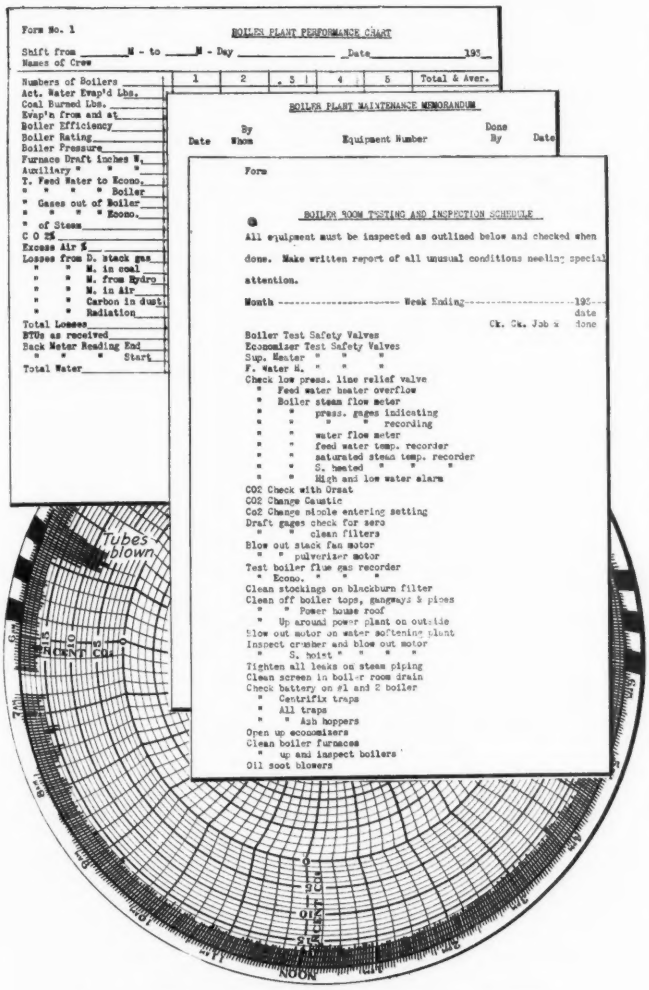

Form No. 1
BOILER PLANT PERFORMANCE CHART
Shift from ____M - to ____M - Day ____ Date ____ 193_
Names of Crew
Numbers of Boilers | 1 | 2 | 3 | 4 | 5 | Total & Aver.
Act. Water Evap'd Lbs.
Coal Burned Lbs.
Evap'n from and at
Boiler Efficiency
Boiler Rating
Boiler Pressure
Furnace Draft inches W.
Auxiliary " " "
T. Feed Water to Econo.
" " " " Boiler
" Gases out of Boiler
" " " " Econo.
" of Steam
C O 2%
Excess Air %
Losses from D. stack gas
" " M. in coal
" " M. from Hydro
" " M. in Air
" " Carbon in dust
" " Radiation
Total Losses
BTUs as received
Back Meter Reading End
" " " Start
Total Water
BOILER PLANT MAINTENANCE MEMORANDUM
Date | By Whom | Equipment Number | Done By | Date
Form
BOILER ROOM TESTING AND INSPECTION SCHEDULE
All equipment must be inspected as outlined below and checked when done. Make written report of all unusual conditions needing special attention.
Month ---------- Week Ending ---------- 193
date
Ck. Ck. Job # done
Boiler Test Safety Valves
Economizer Test Safety Valves
Sup. Heater " " "
F. water H. " " "
Check low press. line relief valve
" Feed water heater overflow
" Boiler steam flow meter
" " press. gages indicating
" " " recording
" " water flow meter
" " feed water temp. recorder
" " saturated steam temp. recorder
" " S. heated " " "
" " High and low water alarm
CO2 Check with Orsat
CO2 Change Caustic
Co2 Change nipple entering setting
Draft gages check for zero
" " clean filters
Blow out stack fan motor
" " pulverizer motor
Test boiler flue gas recorder
" Econo. " "
Clean stockings on blackburn filter
Clean off boiler tops, gangways & pipes
" " Power house roof
" Up around power plant on outside
Blow out motor on water softening plant
Inspect crusher and blow out motor
" S. hoist " " "
Tighten all leaks on steam piping
Clean screen in boiler room drain
Check battery on #1 and 2 boiler
" Centrifix traps
" All traps
" " Ash hoppers
Open up economizers
Clean boiler furnaces
" up and inspect boilers
Oil soot blowers
Tubes blown
PERCENT CO2
NOON

Fig. 3—(Above) Three log sheets for maintenance and operation. Fig. 4—(Below) Typical chart showing normal CO_2 around 16.5 per cent. Corresponding temperature of gases leaving economizer is 250 deg. F.

old boiler plant, before it was torn down, one boiler at a time, to make room for the new, operated at an average efficiency around 55 per cent.

Briefly, the present equipment is as follows: In a new, high boiler room, flooded with daylight from large windows, are five pulverized-coal fired boilers now operating at 168 lb. pressure and superheat from 115 to 125 deg. Each is equipped with economizer, unit pulverizer, induced-draft fan and venturi-type stack. Boilers are of the four-drum, bent-tube type.

The units are not, however, identical. Units Nos. 1 and 2 use the same makes of boiler, pulverizer and instruments; units 3, 4 and 5 other makes. The first group has fin-tube superheaters, the second group smooth-tube. All five units have identical fin-tube economizers of 2,340 sq.ft. All are provided with water-cooled back walls and air-cooled side and front walls.

Heating surface is 7,440 sq.ft. for each boiler in the first group and 6,160 sq.ft. for each in the second. Corresponding furnace volumes are 6,450 and 4,500 cu.ft.

Most of the load to date has been carried by the last three boilers, so that data here presented refer almost exclusively to their performance.

Feedwater is somewhat more than fifty per cent heating returns. Make-up is Lake Michigan water running about 7½ grains per gallon hardness. Treatment is by lime, soda ash and sodium aluminate fed to a hot-process softener. Scale is non-existent. The plant has not turbined a tube in three years.

An unusual, perhaps unique, operating feature is the method of continuous blowdown. The blowdown is discharged without heat exchanger, directly to the settling tank of the softener. Routine blowing of softener sludge simultaneously reduces concentration. Thus the actual blowdown waste of water is reduced from 3 per cent of boiler feed to ½ per cent. Moreover this water is wasted at 212 deg. rather than at boiler saturation temperature.

The coal-handling sequence, similar to that in many other plants, is: Truck to hopper to magnetic separator to skip hoist to 300-ton overhead bunker (inside) to 2-ton weigh larry to pulverizer hoppers.

Ash from furnace bottoms is dropped into the furnace ash pocket by opening and closing a gate. After quenching it is discharged with fly ash chuted from trap (beyond economizer) to hand cars and moved to skip hoist for delivery to an overhead hopper, where it is stored for removal by truck.

Draft for each boiler is produced by a motor-driven induced-draft fan discharging to the 3-ft. 3-in. throat of a venturi-type stack. Rising 51 ft., the stack widens to 5 ft. 6 in. diameter at the top.

Feed is by three-stage turbine-driven centrifugal pumps. All other auxiliaries are motor driven.

Each boiler has its individual instrument board carrying the following instruments:

One 7-pointer draft gage
One CO_2 recorder (that for units 3, 4 and 5 shows also the gas temperatures leaving boiler and economizer)
One recorder for temperatures of saturated and superheated steam
One recorder for temperature of water leaving economizer
One indicating pressure gage

Additional instruments for the whole plant include:

One pressure recorder
One recorder for flow and temperature of water entering economizers.

On each pulverizer indicating thermometers give the temperature of air received from furnace walls and discharged to burners.

This outline of the design reveals nothing unique, with the possible exception of the blowdown system. One

must therefore look elsewhere for an explanation of eighteen months of steam generation at an average efficiency five per cent above the guarantee (85 per cent) and at least 2 per cent above the best efficiency obtained in early 24-hour test.

The high aim of most good operation is to equal test results. The aim and achievement, at Milwaukee, has been to beat it at all times by giving the plant test attention at all times and by adding to this the operating "knowhow" that comes only from accumulated and recorded experience.

In perfection of operating routine it seems safe to say that this boiler room stands unexcelled anywhere by industrial plant or central station.

First comes extreme cleanliness. From boiler top to ash floor it is spotless. Every day the ash floor is scrubbed. Boiler tops are dusted weekly. After every use the skip hoist mechanism is completely cleaned.

A placard gives the name of the shift man in charge. Charts showing shift performance are posted.

Maintenance scheduling and maintenance technique are applied to the limit. First comes routine maintenance. On a broad master sheet are listed all of the routine maintenance operations. In columns for each week black spots indicate the items that must be inspected that week. Each week these are transferred to a work sheet. *Within that week* every scheduled item must be attended to—no excuses allowed. As the items are completed they are initialed. At the end of the week the whole record is transferred back to the master sheet, which then takes the place of alibis if trouble develops.

But routine maintenance can never handle the whole job; unexpected leaks and faults will develop. It is a standing order that any man from foreman up, who first sees these, must enter them on another sheet—with initials. This becomes another work sheet of the maintenance gang, which reports to the boiler house two or three times a week.

In the boiler room, where every man may see it, is posted a continuous graphic record of operating results, with the three shifts lined one above another. This chart, "modernized" daily, shows CO_2, efficiency and rating. It places squarely on each man the duty and pleasure of equalling or beating the other shifts.

By observation of this chart, and by constant study of the instrument board charts at 10-min. intervals, the operators have learned to adjust air feed, fans and dampers and soot-blowing intervals for the maximum efficiency. Another chart (Fig. 2) original with this plant, fits in here and has been a vital factor in the results obtained. It is based on many tests with the fuel used to find the maximum CO_2 possible without exceeding a certain temperature (2,200 deg. to 2,400 deg.) at the tubes, which would permit slagging.

Explosion doors are permanently sealed with plastic. As each shift comes on, boiler settings are rechecked for air leakage around doors. All instruments are checked carefully the first of each month.

Whether all this pays or not is best answered by studying the continuous maintenance of high CO_2 (around 16 per cent) and extremely low stack temperature (averaging around 265 deg.) on Fig. 2.

In water testing, likewise, a standard routine is followed. Samples are drawn from every boiler, and from the softened water at 8-hour intervals. These are tested daily. Boiler water is tested for sulphates and carbonates so that a 2½ to 1 ratio may be maintained. Blowdown is regulated by an alkalinity test. Once a week the Winkler test is applied to determine oxygen in the feed water. Softened water receives the soap test for hardness and the titration for pH. and M.O. alkalinity.

Operating methods have been outlined at length because they are decidedly unusual. Without this intensive control the results obtained would be impossible. These results for a 2½-year period, elaborately analyzed for cross checking, may be seen in Fig. 1.

In its early stages this chart is a history of experimental work and of individual selection and development. Referring particularly to the curve of over-all efficiency, the sharp rise through February, March and April, 1930, is accounted for by a change in operating personnel. The steady, but more gradual rise from then until June, 1931, shows the results of accumulated operating experience. From August, 1931, to date the efficiency has been continuously above 90 per cent, except in one month when it fell to 89 per cent.

As mentioned earlier, these are boiler-unit efficiencies based on coal fired and the gross steam output of the units. Deduction of steam for feed pump drive, and of 25 lb. steam per kw.-hr. to all electric auxiliaries (including pulverizer motors, coal-handling and ash-handling meters and lights) will reduce the over-all boiler room efficiency by about 1.3 per cent if no credit is given for the exhaust steam (which is all utilized).

A 0.3 per cent rise in efficiency, starting in March, 1932, shows the effect of a change to petroleum coke as a fuel. At other times the fuel burned was a high-grade eastern Pennsylvania bituminous coal.

Performance and Costs for Month of September, 1932

BOILER RATINGS	
Average for the month, per cent	150
Maximum over 24 hours	179
Minimum over 24 hours	103
Ave. heat release per cu.ft. per month, Btu	7,400
HEAT ABSORBED AND LOSSES	
Heat absorbed by boiler, per cent	78.704
Heat absorbed by superheater	7.370
Heat absorbed by economizer	4.460
Total over all efficiency	90.534
Heat loss to dry stack gases	4.427
Heat loss to moisture in the coal	0.147
Heat loss to moisture in the air	0.071
Heat loss to moisture from H_2 to H_2O	2.621
Heat loss to unburned carbon	1.000
Heat loss to radiation from furnace, etc	1.200
Total, per cent	100.000

PETROLEUM COKE ANALYSIS

Moist.	Volatile	F. Carbon	Sulphur	Ash	Btu. dry	Btu. wet
2.0	17.29	78.013	2.58	1.63	15551	15240

Item	Description	Amount: Total Cost	Amount: Detail Cost	Unit Cost per M. Lb. Steam
1	Total operating costs	$5,123.22		$0.1893
2	Fuel		$3,531.92	0.1305
3	Labor		745.41	0.0275
4	Power, light, supplies, etc.		845.89	0.0313
	COST TO PREPARE, CRUSH, AND HANDLE ONE TON COAL			
5	Total cost	$0.0600		$0.0021
	Power for crushing		$0.0065	
	Power for hoisting		0.0049	
	Labor		0.0486	
	COST TO PULVERIZE ONE TON COAL			
6	Total cost	$0.2447		$0.0086
	Power for crushing with pulverizer		$0.2354	
	Hammer wear		0.0062	
	Oil		0.0031	
	COST OF ASH REMOVAL PER TON OF COAL BURNED			
7	Total cost	$0.05302		$0.0018
	Power for hoisting		$0.00126	
	Labor		0.04861	
	Oil		0.00315	
	COST TO TREAT 1,000 GALLONS OF BOILER WATER			
8	Total cost	$0.02411		$0.00256
	Chemicals		$0.02161	
	Power		0.00250	

HARD SURFACING VALVES

FOR STEAM SERVICE AT HIGH TEMPERATURES

FOR high-temperature valve work, a metal must be chosen whch has the proper strength and retains its hardness at elevated temperatures. The wearing surfaces must be made of metals which have no tendency to tear or gall each other and which resist wire-drawing and abrasion from sand, silt or scale. A seat metal must also be resistant to oxidation and corrosion in order that it may retain the smooth surface essential to tightness. The coefficient of expansion is also an important factor to be considered. Seat metals and valve bodies should have the same coefficient of expansion to prevent loosening of the rings after repeated heating and cooling.

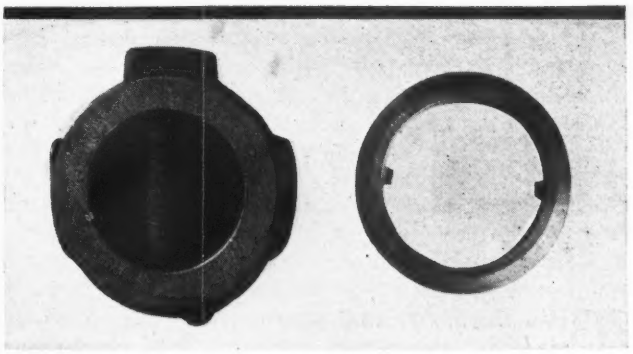
A large mid-western power company, a pioneer in higher steam temperatures and pressures, has effected considerable economies in valve operation by applying Stellite—a hard-facing alloy resistant to abrasion, erosion and corrosion even at high temperatures—to gates, rings, disks, seats, etc.

Figs. 1 and 2 show gates and rings for a 2½-in. gate valve before and after preliminary machining. Figs. 3 and 4 show the gates and rings after hard-facing. In Fig. 3 the hard-facing material appears just as deposited by the oxy-acetylene blowpipe; in Fig. 4, after machining and ready for service.

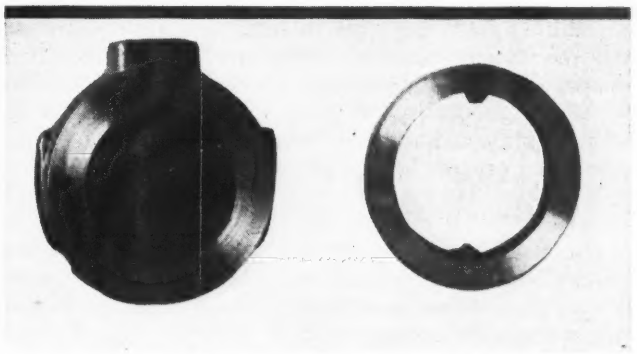
This method has also been used for coating the faces of wedge-type gate valve seats and disks, principally for use on soot blower master stop valves. Since hard-facing, some of these valves have been in service for two years without leaking. In fact, during this plant's experience, hard-surfaced valve seats have never been cut by steam.

Stellite, a non-ferrous alloy of cobalt, chromium and tungsten, is inherently hard and retains its hardness up to a red heat. The high degree of red hardness is due to the fact that the base is cobalt instead of iron. The value of the alloy is intensified when corrosive action is combined with abrasion, as in valve parts for high temperature and pressure service. The coefficient of expansion of this hard-surfacing material is close to that of carbon steel up to 1,300 deg. F.

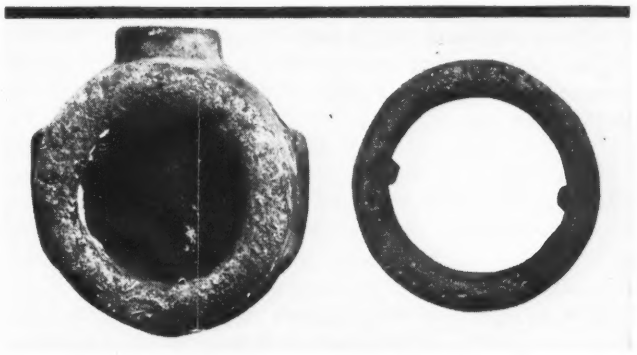
Hard-facing alloy is quickly and easily applied to valve seats and disks by means of the oxy-acetylene process. The surface to be coated is ground or machined to obtain a clean, sound base for the alloy deposit. With an excess acetylene flame, the base metal is brought merely to a sweating heat on the surface and the abrasion-resistant material is melted and flowed on. By this procedure, a strong bond is assured with a minimum of inter-alloying of base metal and hard-facing alloy.



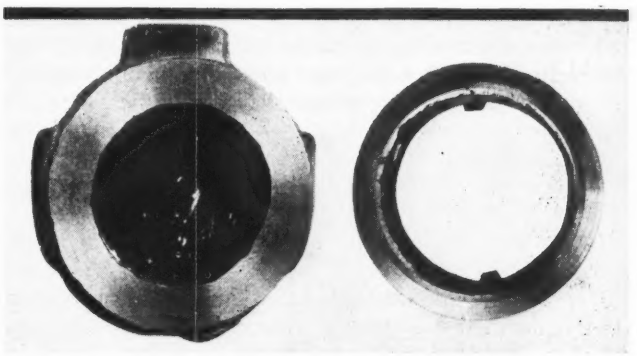
● Original Surfaces



●● Rough Machined

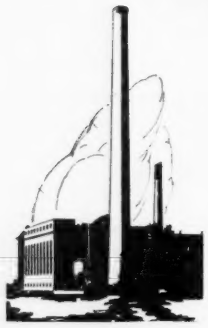


●●● Hard Faced



●●●● Finished

BYPRODUCT POWER DESIGNS



Must be Tailored to Meet Local Conditions

By M. K. BRYAN
Chas. T. Main, Inc.
Engineers, Boston, Mass.

THE thermodynamic superiority of steam power made as a byproduct of process heat supply was pointed out by the writer in the February number of *Power*.[1] Attention was called to the broadening field for the application of byproduct power generation which is resulting from advances in steam generating practice and the development of steam and power generating equipments. The importance of determining specifications for the quality of process heat and of knowing both quantity and time, or occurrence, relations of the power and process heat requirements was stressed.

Conditions Determine the Design

The economics of byproduct power installations are materially affected by these conditions and by the installation's physical surroundings. Among the more important of these factors are:

(a) The cost of the power which will be displaced by the contemplated installation. (Byproduct power can be produced for 5,000 to 7,000 B.t.u. per kw.-hr. or, say, a fuel cost of 0.8 to 1.25 mills. The principal element of cost is the fixed charge on the capital invested.)

(b) The physical characteristics, both structural and economic, of all steam and power-generating equipment installed in the property.

(c) The load curves of power and of process steam.

(d) Other sources of power and the cost of power taken from or delivered to them. (It may be necessary to supplement the contemplated byproduct power supply, or a surplus of byproduct power may be available for sale after the plant load is supplied.)

The relations of these factors and their relative influences are not fixed, but vary in different cases. In each instance local conditions will establish rather definite relations. The actual economics will, in a large measure, be determined by the skill with which the plan of the byproduct power installation is formulated to take the full value from existing property in combination with the well-developed appliances and equipments available and needed to give the proper balance of heat requirements and power demands.

Contemplated installations for existing plants can be considered under one or the other of two general case classifications, as follows:

(a) Where the existing boiler plant is used, possibly with minor changes, or

(b) Where the existing installation of steam generating equipment is materially changed either by extensive remodelling or by replacement. In each case a definite amount of process heat of defined quality must be supplied and power, although of secondary importance, is to be produced in the largest profitable amount.

The influence of existing physical factors upon the plans for an installation may be illustrated by considering a situation in which the existing boiler plant and process requirements establish general fundamentals, as follows:

(a) The plant's boilers are good for 225-lb. working pressure and can accommodate large superheaters such that a turbine throttle steam condition of 200 lb. and 650 deg. F. total temperature could be met by installing superheaters;

(b) The high-pressure steam piping system is built with 250-lb. standard cast-iron valves and fittings;

(c) Process heat requirements are 40,000 lb. per hour of dry steam at not less than 10-lb. pressure, and it is preferred that this steam be superheated 5 or 10 deg.;

(d) The location of the proposed turbine relative to the processes indicates a turbine exhaust condition of 15-lb. pressure and 20 deg. superheat as necessary to satisfy condition (c);

(e) It is desired to produce as large an amount of power with non-condensing turbines as is profitable to replace the power costing 7½ mills per kw.-hr.

Considering the above conditions, to determine what physical restrictions they impose, it is found that, whereas the boiler construction would permit a total steam temperature of 650 deg., good practice would limit this to 480 deg. with the cast-iron valves and fittings which are installed. Condition (d) definitely states the amount of heat which must be present in each pound of turbine exhaust if it is to be used directly in the processes.

The power which can be developed from the steam is directly proportional to the heat extracted from it by the turbine, and the power produced will, therefore, be proportional to the difference in heat at the throttle and at the exhaust. The heat in the exhaust is definitely established by condition (d) as 1,174 B.t.u. per lb. The temperature at the throttle is definitely established as a maximum of 480 deg. if the present high-pressure piping is to be used and as 650 deg. F. if this piping is to be replaced with cast-steel valves and fittings.

This reduces the problem to finding out what steam pressure will be most profitable with the present piping and comparing this with the condition using to best advantage the maximum steam pressure and temperature.

The following table shows the power available, using different initial pressures and a constant total steam temperature of 480 deg.:

[1] "Heat Plus Power Equals Dollars Saved," Page 66.

Col. 1 Throttle press. at 480 deg. total temperature	b. Heat content, throttle steam	2 Heat content, 1 lb. exh. steam. Condition (d)	3 Heat per lb. of steam converted into power	4 Lb. steam per kw.-hr. on switchboard	5 40,000 lb. steam Kw. from
200	1,255.2	1,174	81.2	46.1	868
175	1,258.1	1,174	84.1	44.5	900
150	1,260.9	1,174	86.9	43.1	928
135	1,262.6	1,174	88.6	42.2	949
125	1,263.7	1,174	89.7	41.6	963

Col. 1 = From Steam Tables
Col. 2 = From Steam Tables
Col. 3 = Col. 1 minus Col. 2
Col. 4 = $\frac{1.1 \times 3{,}415}{\text{Col. 3}}$ where 3,415 is B.t.u. equiv. of one kw., 1.1 is to allow for gen. eff. 93 per cent and mech. loss of 2 per cent.
Col. 5 = $\frac{40{,}000}{\text{Col. 4}}$

It is seen that the power output is increased about 11 per cent by reducing the pressure from 200 lb. to 125 lb. It is important to remember how the specification for exhaust heat, condition (d), affects this performance.

The steam rates given in Col. 4 are not the maximum obtainable with a commercial turbine. The steam rate for such a machine, without any stipulation of exhaust condition other than 15-lb. pressure, would be about 31.5 lb. per kw.-hr. with 200-lb., 480-deg. throttle conditions. This would allow making 1,270 kw.-hr. from 40,000 lb. of steam, but the exhaust from the turbine would contain only 1,133 B.t.u. per lb., and instead of being superheated 20 deg. it would be wet, carrying about 3¼ per cent moisture. This moisture could be separated and high-pressure steam added to give the mixture of exhaust and high-pressure steam the required properties.

There would be, however, no advantage in doing this. A simple calculation shows that the high-pressure steam required would be about 14,900 lb., leaving 26,000 lb. to pass through the turbine and reducing its power output to about 825 kw., or less than could be produced with a less efficient and less expensive turbine under the same conditions.

Now to examine the possibilities with the piping system changed to allow the use of higher temperature steam at the throttle. Calculation shows the following:

Throttle Condition	Steam Rate	Exhaust Condition
200 lb., 650 deg.	27.5 lb. per kw.-hr.	15 lb., 95 deg. superheat
200 lb., 600 deg.	29.2 lb. per kw.-hr.	15 lb., 50 deg. superheat
200 lb., 570 deg.	29.8 lb. per kw.-hr.	15 lb., 25 deg. superheat

Here again use of maximum pressure and temperature does not give the desired exhaust conditions.

The power output with this exhaust condition would be about 1,340 kw., or an increase of about 390 kw., made possible by changing cast-iron pipe fittings and valves to cast-steel and by installing the largest superheaters.

It is proper to ask: "Why not use the maximum pressure and temperature and desuperheat the turbine exhaust from 95 deg. to the required 20 deg.?" A desuperheater would probably be required in the installation to condition the steam which passes reducing valves and its cost, therefore, cannot be avoided. The addition of water for desuperheating will add weight to the exhaust steam, and accordingly the throttle steam will be reduced in quantity by the amount of desuperheater water added. The amount used by the processes is a fixed quantity. Calculation shows that 1,400 lb. per hour of 200-deg. water will be required. This reduces the turbine throttle steam from 40,000 lb. per hour to 38,600 lb. per hour, and accordingly the power output with a 27.5-lb. water rate will be 1,402 kw.

These results give a general indication of the advisable direction for detailed analysis. It has been found that: (a) About 950 kw. can be made with the present boiler plant equipment by adding superheaters for 480 deg. temperature; (b) With new valves and fittings and a superheater for 570 deg., 1,340 kw. can be made; and (c), with a still larger superheater, 1,402 kw.

These figures are approximate and indicate the trend for power production with certain proposed plans. They were shown for the purpose of pointing out how physical conditions may affect the result rather than as an example of a solution. A much more detailed investigation is necessary before any definite decision can be made. While it may appear that the displacement of power costing 0.75c. per kw.-hr. will be enough to justify the increased cost of equipment, too many considerations will affect the net savings over a period of time to allow the analysis to stop with a set of figures made up as the foregoing have been made.

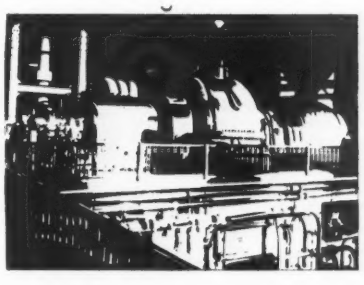
The major item in byproduct power cost is the capital charge on the investment. A large element in fixed charges per unit of output is the load factor of the machine. When it is remembered that the output varies with steam flow to process a new element in the load factor is discovered. Load factor is conventionally thought of as determined solely by power requirements.

In the case of byproduct power generation, load factor is determined by two factors, namely: (a) the varying requirements of the processes for steam; and (b) the ability of the power system to absorb the varying quantity of power which can be generated from process steam. It is apparent that the force of each of these factors will operate differently in individual cases. It is possible to have such a relation between power and steam demand that, whereas the figures from some data would indicate use for, say, a 1,500-kw. machine, the effect of this relation integrated for a period of some duration would be such as to bring the average loading, and hence output per dollar of investment, down to the point at which it would actually be more profitable to use a smaller machine, one, say, of 1,000-kw. rating, sacrificing something in power output for a saving in cost.

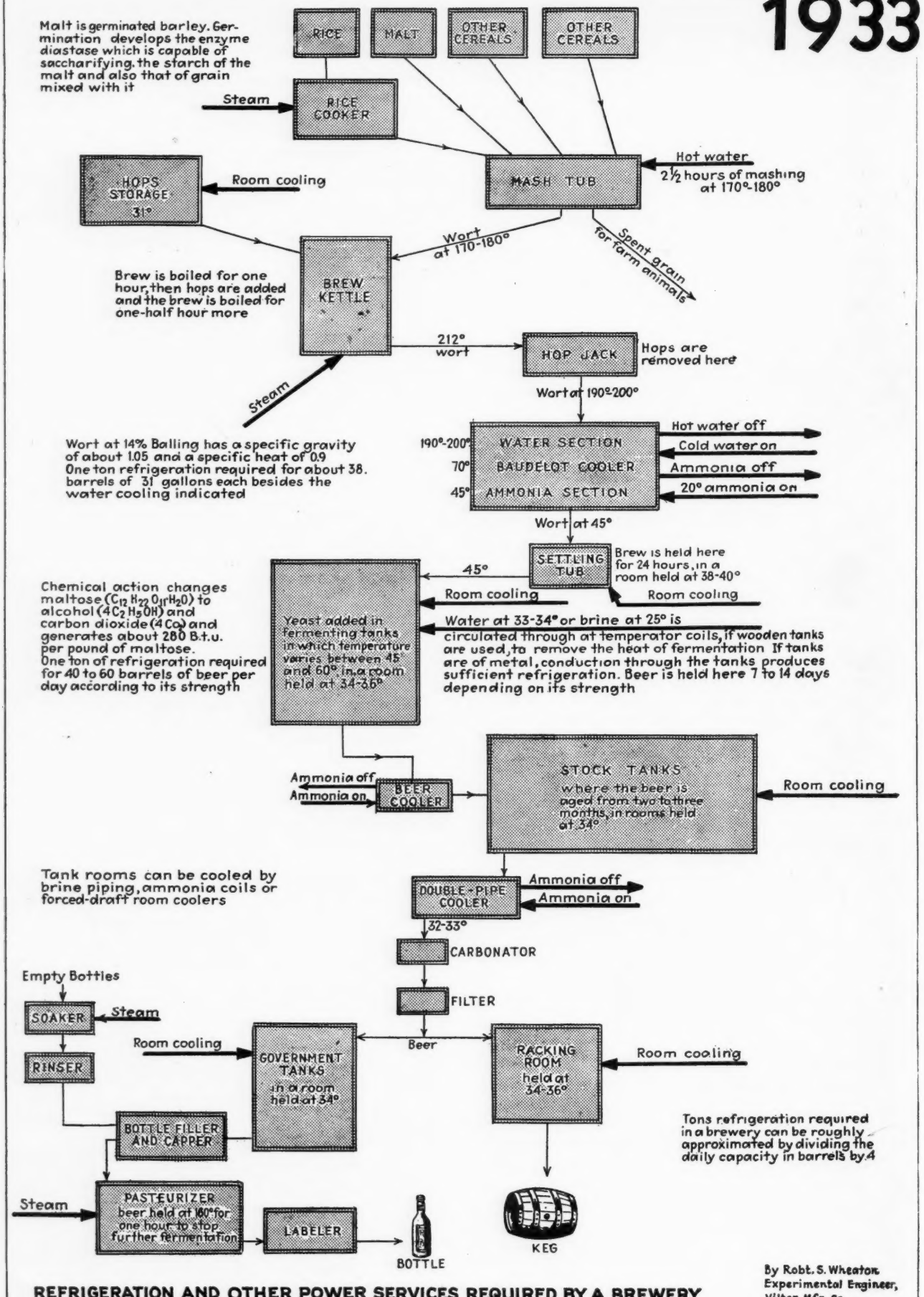
Further generalization on this point is of no use. The only advisable procedure is a detailed analysis of each case from the most complete assembly of its data procurable. This data must recognize and record all the constant and variable physical factors. The detailed analysis must translate these into the language of dollars to be spent and saved. Experience from studying different cases develops an intuitive sense for appraising certain factors and their effect. This eliminates considerable of the cut-and-try methods otherwise necessary.

These problems appear straightforward and simple of solution, yet the writer does not know of any industrial power problems with as many pitfalls or where errors in analysis are so glaringly exposed as in these byproduct power applications. The apparent simplicity of these is insidious and lures one into an attitude for generalization, whereas thorough dissection of the problem is necessary if all its possibilities are to be realized in the solution.

The third and concluding article in this economic analysis of byproduct power will appear shortly. It will describe actual installations where the principles here outlined have been applied and where operation has confirmed their correctness.



1933


Malt is germinated barley. Germination develops the enzyme diastase which is capable of saccharifying the starch of the malt and also that of grain mixed with it
RICE
MALT
OTHER CEREALS
OTHER CEREALS
Steam
RICE COOKER
HOPS STORAGE 31°
Room cooling
MASH TUB
Hot water
2½ hours of mashing at 170°-180°
Wort at 170-180°
Spent grain for farm animals
Brew is boiled for one hour, then hops are added and the brew is boiled for one-half hour more
BREW KETTLE
212° wort
HOP JACK
Hops are removed here
Steam
Wort at 190°-200°
Wort at 14% Balling has a specific gravity of about 1.05 and a specific heat of 0.9
One ton refrigeration required for about 38 barrels of 31 gallons each besides the water cooling indicated
190°-200°
WATER SECTION
70°
BAUDELOT COOLER
45°
AMMONIA SECTION
Hot water off
Cold water on
Ammonia off
20° ammonia on
Wort at 45°
SETTLING TUB
Brew is held here for 24 hours, in a room held at 38-40°
45°
Room cooling
Room cooling
Chemical action changes maltose ($C_{12}H_{22}O_{11}H_2O$) to alcohol ($4C_2H_5OH$) and carbon dioxide ($4CO_2$) and generates about 280 B.t.u. per pound of maltose.
One ton of refrigeration required for 40 to 60 barrels of beer per day according to its strength
Yeast added in fermenting tanks in which temperature varies between 45° and 60° in a room held at 34-36°
Water at 33-34° or brine at 25° is circulated through at temperator coils, if wooden tanks are used, to remove the heat of fermentation If tanks are of metal, conduction through the tanks produces sufficient refrigeration. Beer is held here 7 to 14 days depending on its strength
Ammonia off
Ammonia on
BEER COOLER
STOCK TANKS
where the beer is aged from two to three months, in rooms held at 34°
Room cooling
Tank rooms can be cooled by brine piping, ammonia coils or forced-draft room coolers
DOUBLE-PIPE COOLER
Ammonia off
Ammonia on
32-33°
CARBONATOR
FILTER
Empty Bottles
SOAKER
Steam
RINSER
Room cooling
GOVERNMENT TANKS in a room held at 34°
Beer
RACKING ROOM held at 34-36°
Room cooling
BOTTLE FILLER AND CAPPER
Tons refrigeration required in a brewery can be roughly approximated by dividing the daily capacity in barrels by 4
Steam
PASTEURIZER beer held at 160° for one hour to stop further fermentation
LABELER
BOTTLE
KEG

REFRIGERATION AND OTHER POWER SERVICES REQUIRED BY A BREWERY

By Robt. S. Wheaton
Experimental Engineer,
Vilter Mfg. Co.

Refrigeration For 1933 Breweries

By FRED OPHULS and A. B. STICKNEY
President *Engineer*
Fred Ophuls & Associates, Inc.

WHEN legal beer comes, brewery executives will face at once a difficult practical problem of tuning up, revamping or even rebuilding of plants. In the light of 1933 engineering, 1917 equipment and methods are, in general, too wasteful to be tolerated. This was clearly pointed out in February *Power* which showed how the most modern methods of generating steam, electricity and refrigeration may easily cut the coal bill 50 to 60 per cent. The present article continues this study with special reference to the whole refrigerating problem of the modern brewery.

Does it pay best to recondition the old refrigerating machinery or install a new plant in the reopened brewery? While no such outstanding advances have been made in refrigerating practice as were pointed out for the power plant, there nevertheless has been continuous refinement of detail, improvement in types of apparatus and better methods of operation.

Many of these advances can be applied to old plants at small cost. Consequently it is not fair to compare a new plant to an old one, but rather to compare the new plant to various possible modifications of the old and these with each other, taking account of the investment and operating expense with each set-up.

Refrigeration is used in the brewery for cooling wort from the temperature attainable with available water to the temperature at the start of fermentation, for removal of heat of fermentation, for cooling beer going to stock cellars, for maintaining the temperature of fermenting cellars, stock cellars, racking-off cellars, and hop storage, and for cooling the beer in the racking-off cellar and at the bottling machines. **The lowest temperature required is 31 deg. F.[1] in the hop storage, the highest is 40 to 45 deg. F. in the fermenting cellars. Careful and continuous control of temperature is of utmost importance in maintaining quality of product.**

In most breweries, it was customary to cool wort to within about 10 to 20 deg. of the water supply temperature in counterflow coolers, through which the brewing water flows in the opposite direction, thus recovering most of the heat in the wort. These coolers might be either open or closed. The wort was then further cooled to 40 to 45 deg. in a second cooler (or an additional section of the first) by direct-expansion ammonia or refrigerated brine. Since it was customary to do the wort cooling from a given brew in a period of not over four hours, the refrigerating plant had to handle this cooling load in this period.

It is impossible to set up typical requirements, since the magnitude of the wort cooling load depends on the magnitude of the brew and the temperature of the water supply. But assume, for illustration, a 435-bbl. brew with a cooling water temperature of 75 deg. F. The wort, having a specific gravity of say 1.047, and a specific heat of 0.9, must be cooled from 85 to 45, or 40 deg. Allowing a 5 per cent heat loss, the required refrigeration is: $435 \times 259 \times 1.047 \times 0.9 \times 40 \times 1.05 =$ 4,450,000 B.t.u. If this must be handled in 4 hours, it requires refrigeration at the rate of

$$\frac{4{,}450{,}000}{12{,}000 \times 4} = 92.7 \text{ tons}$$

A modern method of wort cooling is to refrigerate cooling water at a uniform rate and to store it, drawing on the stored supply to meet wort cooling requirements. Cooling is then done all the way to 45 deg. F. with water, which comes into the cooler at say 35 deg. F. In the above example, assuming two brews per day, the refrigeration would be applied to the water at a uniform rate of $\frac{2 \times 4{,}450{,}000}{12{,}000 \times 24} = 30.9$ tons. The brewing water is about 140 per cent of the wort, so that a total of $2 \times 435 \times 1.4 = 1{,}178$, say 1,200, barrels are required. The water would be cooled at a uniform rate of 50 bbl. per hr. and stored. If the two brews are at an interval of 5 hours, a cold-water storage of 750-bbl. capacity would be required. If the two brews are 12 hours apart, this requirement would be reduced to 400 bbl.

In the fermenting cellar, the method of application of refrigeration and also its amount depends on the brewing method. Thus if attemperator coils are used in the fermenting vats to prevent the wort from rising above a predetermined temperature, the requirements are different than if metal tanks are used, and refrigeration is applied through heat leakage to the air in the cellar. Also, if the temperature is allowed to rise during fermentation, and heat so generated is removed in the beer cooler between fermentation and stock cellars, the refrigeration required in the fermenting cellar is less and in the beer cooler is more, than if a uniform temperature is maintained. Similarly, if the fermentation is completed in the fermenting cellar and the beer is artificially carbonated, requirements are different than if young beer, partially fermented, is withdrawn and introduced into the stock cellars to produce natural carbonation.

While no exact typical requirements for refrigeration in a brewery can be set up, in order to give a general picture, the following figures, based on a 165,000-bbl. brewery in the tropics for which power requirements were given last month, are here included:

	Ton Days per Year
Heat leakage from all cellars	11,370
Heat introduced to refrigerated space by	
Wash water	2,030
Men and lights	300
Wort cooling	6,270
Heat of fermentation	4,350
Conditioning air in fermenting cellar	1,240
Cooling beer from fermenting vats to stock tubs	1,440
Bottling	800
	27,800

Normal load on this plant on a two-brew-day, of which

[1] In brewery work three different temperature scales are used. These are Reaumur, Centigrade, and Fahrenheit. In this paper Fahrenheit is used throughout. To convert to Reaumur, subtract 32 and multiply by 4/9; to convert to Centigrade, subtract 32 and multiply by 5/9.

there are 78 per year is about 111 tons, and on a one-brew-day, of which there are 222 per year, is about 76 tons. On Sundays and holidays, when no brewing is done, the load is somewhat less, ranging from 60 tons down to 40 tons, depending on the amount of fermentation taking place. With two 76-ton machines, each with capacity control, operation of one would suffice for all but about 100 days, leaving a spare for all times except peaks.

There are three outstanding improvements in cellar refrigeration. These are insulation, unit coolers and flooded operation of direct expansion piping. Modern cellar insulation would follow modern cold-storage practice—curtain wall construction with a practically unbroken envelope of sheet cork. This is not applicable to old cellars, and while it is possible to apply sheet cork to existing buildings, it is expensive. The old type of cellar construction, with brick, tile and air spaces, is not efficient from the insulating standpoint.

Unit coolers, developed for air conditioning, are being widely applied for space refrigeration. In these, the cooling surface is concentrated, and operated flooded, with high air velocities over it. The air from the space to be cooled is blown through the unit and distributed to the various parts of the room. For brewery work these units have the advantages of giving more uniform conditions, eliminating drippage from overhead coils and allowing a higher suction pressure at comparable equipment cost. If extensive coil renewal is required in rehabilitating cellars, unit coolers should receive consideration.

Flooded operation of direct-expansion piping allows use of higher suction pressures through improved heat transfer and effective utilization of the entire pipe surface. By flooded operation is meant the passage of more liquid through a coil than can be evaporated. The excess liquid is trapped out and recirculated. In this way the entire inner pipe surface is kept wet with evaporating refrigerant. By use of accumulators and liquid pumps this improvement is applicable to existing coil surface which was not designed for its use.

Higher suction pressures made possible by the above two methods have two advantages: first, less power, and second, smaller displacement required in compressors to handle a given load. For a 100-ton plant having a discharge pressure of 185 lb., the following table shows the difference:

Temp. of evaporating ammonia, deg. F.	5	15	25
Suction pressure, lb. per sq.in. gage	19.6	28.4	39.0
Volume suction gas to be handled, c.f.m.	352	282	228
Indicated hp. required	139	116	96

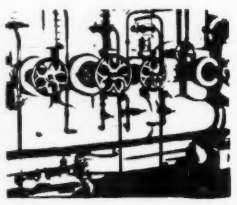
In many old breweries there was also an ice plant, and the same suction pressure was carried on both. In this case approximately the conditions in the first column obtained, and the coil surface in the cellars was proportioned to the large resulting temperature difference, insofar as it was proportioned at all. Generally it was installed by rule of thumb, one foot of 2-in. pipe to so many cubic feet of fermenting cellar, etc. Study of the existing pipe surface and its layout, together with knowledge of the heat transfer to be expected with various kinds of operation, will generally show that the suction pressure can be raised materially with existing equipment and relatively minor changes. If an ice plant is to be operated, it will probably prove advantageous to operate at two suction pressures, either by operating different compressors on the two loads if these machines are available, or by installing on the low suction a booster compressor discharging into the high suction.

The modern compressor runs at a much higher speed, 200 r.p.m. being not uncommon in horizontal double-acting machines, and 300 in vertical single-acting units. Hence a much smaller compressor is required. Compound compression and multiple-effect compression, both of which make possible power savings compared to simple compression, have been widely applied. Control of compressor capacity through the use of clearance pockets has been developed. Valve areas are larger, leading to reduced wire-drawing losses. Numerous refinements of detail have been introduced. As was pointed out last month, if full advantage is to be taken of advances in the power field, bleeder-type turbines will generate all power, including that for the electrically driven compressors. Thus it is wise to weigh carefully the advantages of new machines against the cost of making the change, taking account of the entire picture.

If an entirely new refrigerating plant is to be installed, the possibilities of the centrifugal compressor, driven at high speed by a turbine, and employing some other refrigerant than ammonia, should be investigated.

In the operation of compressors, conditioning of the suction gas leads to better operation and lower maintenance. In most old installations, slugs of liquid ammonia come back to the compressor from time to time, and in many there is a more or less continuous return of wet gas. This liquid going to the compressor not only interferes with proper lubrication, leading to scored cylinders and high maintenance, but also cuts down the capacity of the compressor without a compensating reduction in power. Large slugs of liquid going to the machine are likely to lead to serious accidents, such as blowing out of cylinder heads. By the installation of accumulators, this condition can be obviated.

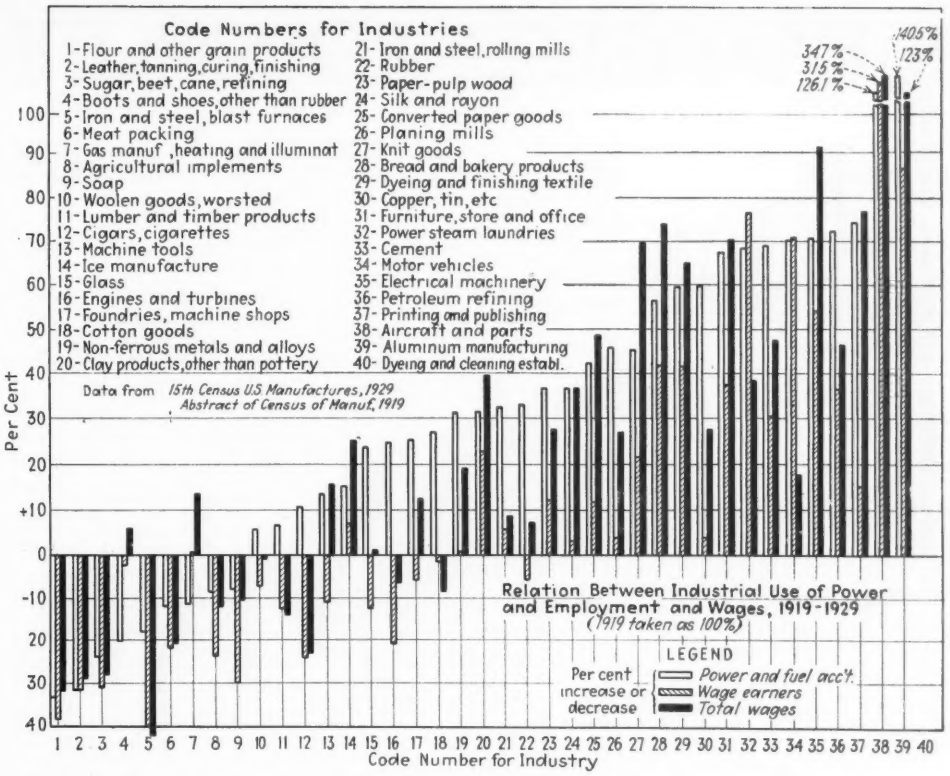
Introduction of shell-and-tube type condensers, which may be of either the open or closed type on the water side has resulted in higher heat transfer rates per unit of surface, and also the entire surface is always active, which was often not the case in the old condensers. Whether the open or closed type should be used is a matter of the water circuits available. The open type has the higher heat transfer, but may be wasteful of pumping power unless the water circuit is right. Purging methods have been improved, and it is no longer excusable to carry any substantial partial non-condensible gas pressure in the condensers.



Dependable automatic regulation of temperature and of refrigerant feed is now possible, and the use of these in the proper locations is helpful in obtaining uniform and economical operation. Instruments and controls, such as mercury-column suction gages, oil-column liquid-level gages, and venturi meters for metering liquid flow, are also of great help in operating the plant.

Study of the refrigerating plant is necessary to show how existing equipment can best be utilized and what expenditures are necessary and economically justified. Many of the advantages of the most modern plant can be obtained in the old plant with relatively small changes. The proper program for any individual plant can only be determined by a competent engineering study.

By
WALTER N. POLAKOV
Consulting Engineer



POWER and EMPLOYMENT

IS THERE any relation between the use of industrial power and employment, or has technologic progress been responsible for unemployment and the reduction of wages? Data of the 15th U. S. Census of Manufactures seem to give a definite answer. For the decade 1919-1929, the period of widest application of technologic improvements in industry we compared the percentages of change since 1919 in: (1) Cost of fuel and purchased energy, (2) Number of wage earners (average for the year), and (3) Wages (not including salaries) for the industries.

As the efficiency of power generation was increased during that decade, the increase in the cost of fuel and energy is necessarily smaller than the actual increase of power output. The number of wage earners, being an average for the year, was somewhat reduced during the last quarter of 1929; thus the percentage of increase as shown is smaller than the actual up to late 1929.

In other words, using these Census data we do not get an accurate relationship between power use and employment, since power use increased more rapidly than its cost and because the number of wage earners was really larger than reported. Since, however, these inaccuracies tend to make the relationship less pronounced rather than to exaggerate it, we feel that the established ratios are on the safe side.

Now, what is the tendency? We have combined both the producer and consumer goods industries into 40 major groups, representing the following totals:

	1919	1929	Per Cent Increase
Power	$1,087,574,000	$1,265,250,000	16.35
No. of wage earners	5,121,815	5,423,744	6.03
Total wages	$5,834,078,000	$7,041,630,000	20.6
Average pay per year	$1,138	$1,298	13.9

Of the 40 groups studied, 31 increased their power account, 28 increased the wages paid and 22 increased the number of wage earners.

In plain words, this summary means that, *with the increased use of power and advanced technology, employment and wages have increased.*

Individually these 40 groups of industry show, as would be expected, considerable fluctuations.

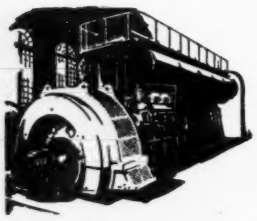
Exceptional cases are represented by new rapidly growing industries such as cigarettes, where automatic processes displaced handicraft. Here we see the power account increasing 11.2 per cent while wages dropped 23.1 per cent and the number of workers reduced 24.1 per cent. The manufacture of gas presents an exception in the opposite direction. Due to the improved technology of gas production the fuel and energy account was reduced 10.8 per cent, yet the wages rose 14.02 per cent although the number of wage workers remained nearly the same, increasing only by 0.3 per cent.

The typical changes, characterizing the effect of increased power consumption on the amount of wages may be plainly seen in such vastly dissimilar industries as Steel Rolling Mills and Rayon; Printing and Textile Finishing. Two of these are continuous processes and two jobbing; two of them notoriously progressive technically and the other two equally notoriously conservative, yet all show the same tendency.

	Steel Roll. Mills	Silk and Rayon	Textile Finishing	Printing Publishing	Aluminum Products
Power	+32.7	+37.1	+59.1	+74.2	+140.5
No. of employees	+ 5.3	+ 2.9	+41.6	+14.9	+ 86.1
Wages	+ 8.06	+37.1	+64.7	+76.6	+123.0

It is noteworthy that almost in every group of industry the increase in wages was larger than the increase in the number of wage-earners, whenever power use increased. It is evidently due to the fact that with the advent of automatic power machinery the employment of common labor was diminished and higher paid, mechanically competent men drew a larger pay.

STEAM-DIESEL POSSIBILITIES in the Boston Post Office



By EDGAR J. KATES
Consulting Engineer, New York

IN A recent number of *Power**, D. D. Eames demonstrated, by means of an independent heat and power analysis of the new Boston Post Office, that the Government could have effected a net annual saving of $16,300 by installing a steam power plant instead of buying street current. A 1,250-kw. steam power plant, he showed, consisting of two 500-kw. and one 250-kw. units and costing $102,000 installed, would have been ample in size and would have reduced the over-all annual cost of power and heat (including fixed charges) from $88,100 to $71,800.

The present writer has no fault to find with Mr. Eames' conclusion that a steam power plant would have been economically sound. In fact it would have been one of those "self-liquidating projects" which the Reconstruction Finance Corporation is seeking to make in order to increase business and relieve unemployment.

In view of the established reliability and the reduced cost of modern diesel engines, however, it will be interesting to consider the economic effect of introducing a diesel engine to generate part of the power.

A combination steam and diesel power plant becomes worthy of consideration because of the large amount of steam required solely for power generation during the spring, summer and fall months. That is to say, power would be, at these times, the sole reason for steam expense, instead of a byproduct of the heating steam requirements of the building. If a diesel engine can produce enough power at lower cost during the warm months to more than offset its own fixed charges, then the diesel-steam combination would be even more economical than the all-steam power plant.

Table 1, showing the distribution of steam in the all-steam power plant classified by seasons, has been derived directly from Tables 1 and 3 in the original article. It clearly discloses that the steam engines effect their savings primarily in the winter; in these four months the generation of 816,000 kw.-hr. is chargeable with only 4,270,000 lb. of steam, i.e., only 5.2 lb. per kw.-hr. In the summer, however, the steam charged to power rises to 28 lb. per kw.-hr. Since the fuel cost of steam is 36.5 cents per 1,000 lb. according to the figures used by Mr. Eames, the cost of the coal alone for the power generated in the summer is 1.02 cents per kw.-hr. Not only will a diesel engine generate power for less than half this fuel cost, but it will also permit a considerable reduction in boiler room labor.

The following analysis for a combination plant is based on substituting a 500-kw. diesel unit for one of the 500-kw. steam units in Mr. Eames' plan, thus making a plant consisting of one 500-kw. diesel, one 500-kw. steam and one 250-kw. steam. From the data available it appears that a 500-kw. diesel unit would be large enough to supply the entire load in the summer. The monthly consumption is 143,000 kw.-hr., and even if as much as 80 per cent of this were consumed in 12 hours per day, the average load during those hours would be only 318 kw. If necessary, however, the 250-kw. steam unit could supplement the diesel and at the same time furnish part of the 300,000 lb. per month of low-pressure steam required in June, July and August. Furthermore, since steam must be kept up during the summer, the steam power units are always available as reserve for the diesel. (A more complete analysis might even show that a smaller diesel, of say 350 or 400 kw., would effect a larger over-all saving.)

To be conservative, it is assumed that no by-product power at all is generated by the steam engines in the summer, but that they consume 210,000 lb. of additional steam in generating 7,000 kw.-hr. during occasional periods of diesel engine shutdown for inspection, etc. Adding this to the steam required for heating makes a total of 2,550,000 lb. of steam for the four summer months. The bulk of the summer power load, amounting to 565,000 kw.-hr., will be carried by the diesel. At an efficiency of 10.5 kw.-hr. per gal., the diesel fuel consumption will be 53,800 gal.

In the spring and fall, the heating steam is 19,140,000 lb. Power consumption is 656,000 kw.-hr., which at an economy of 32 lb. of steam per kw.-hr. would require 21,000,000 lb. if generated by the steam engines. This would total 40,140,000 lb. if there were no coincidental use of steam. However, Mr. Eames' analysis showed that the total steam for heat and power in the spring and fall was only 26,984,000 lb., which indicates a coincidence of 13,156,000 lb. His steam distribution was therefore approximately as follows:

	Pounds
Steam to engines and then to heating system	13,156,000
Steam through reducing valves to heating system	5,984,000
Total heating steam	19,140,000
Steam to engines and then to waste	7,844,000
Total	26,984,000

In the combination diesel and steam power plant one steam and one diesel engine would be running during the spring and fall, and there would be a load distribution control system actuated by the pressure in the steam heating main whereby the steam engine load would be restricted to the point where no exhaust steam would be wasted. Thus the by-product power generated by the steam engine would be $\frac{13,156,000}{32} = 412,000$ kw.-hr. The diesel could carry the remainder of the load or 244,000 kw.-hr., but to allow for inspection shutdowns, etc., it is assumed that the diesel will generate only 240,000 kw.-hr. and consume 22,900 gal. of fuel. The remaining 4,000 kw.-hr. will be produced by the steam engine; this will consume an additional 128,000 lb. of steam, the exhaust of which will be wasted.

In the four winter months the steam distribution for the all-steam power plant, computed similarly, is:

*POWER, October, 1932, page 172.

	Pounds
Steam to engines and then to heating system	21,828,003
Steam through reducing valves to heating system	20,752,000
Total heating steam	42,580,000
Steam to engines and then to waste	4,272,000
Total	46,852,000

In the combination power plant, it is theoretically possible to eliminate the entire waste of steam-engine exhaust by means of the diesel engine, thus reducing the steam consumption 4,272,000 lb. and saving $1,550 worth of coal. Actually, however, there will be periods when it will not pay to run the diesel engine because of the very light load it would carry. In the absence of complete data it will be assumed that the steam consumption will be reduced 2,500,000 lb. The corresponding power, 78,000 kw.-hr., will be produced by the diesel, which will consume 8,700 gal. of oil (the efficiency being reduced to 9 kw.-hr. per gal. because of the light load). Besides reducing the steam consumption in the winter, the diesel will also serve as an excellent standby unit.

The consumption of steam and diesel fuel in the combination plant is summarized for the year in Table 2. It will be noted that the total steam for power and heat is 25,986,000 lb. less than for the all-steam power plant, against which is offset 85,400 gal. of diesel fuel.

There are several other items to be considered in estimating the total power cost in the combination steam and diesel plant. For one thing, the initial cost of the 500-kw. diesel unit will probably be somewhat greater than the steam unit it replaces. It is estimated that the additional cost will not exceed $12,500, making the total cost of the engine room equipment $114,500.

In the Accepted Plan (steam generated, power purchased), steam is required day and night even in the summer, and 3 firemen are allowed for 52 weeks per year. The proposed enlargement of the boiler room crew for the steam power plant consisted in using 3 coal and ash men for 52 weeks per year instead of 35 weeks. This enlargement is not required by the combination steam and diesel plant because this plant requires practically the same amount of steam in the summer as the purchased power plan. Consequently, the item of boiler room labor is not increased as in the all-steam power plant. The same is true of boiler room maintenance. The engine room labor will be the same as in the all-steam power plant. There are the same number of units, and a good steam engineer can easily take care of the diesel.

Engine room maintenance for the all-steam power plant was estimated by Mr. Eames at $1,000 per year. This will be increased $250 to allow for the greater maintenance cost of a diesel over a steam engine.

The item of water, ash removal, etc., was given as $900 for the purchased power plan and as $1,200 for the plan with steam power generation. In the steam and diesel combination the steam produced and coal burned is only 3 per cent greater than in the purchased power plan. This item is therefore estimated at $900 for the combination plant.

Insurance on the steam engine power plant, which was $200 for an investment of $102,000, will increase to $225 for an investment of $114,500 in the combination power plant. Likewise, fixed charges will be increased by 10 per cent of $12,500, or $1,250 per year.

The above data are utilized to compute Table 3, which shows the comparative yearly costs of supplying both heat and power by three different methods, (*a*) The Accepted Plan, with steam generated and power purchased, (*b*) The Eames Proposed Plan, with steam and power generated by all-steam equipment, and (*c*) The New Proposed Plan, with steam and power generated by a combination diesel and steam plant.

The price of diesel fuel is estimated at 5 cents per gallon. At the present time an excellent grade of diesel fuel, a distillate of 39 sec. Saybolt viscosity at 100 deg. F., can be obtained in Boston in tank wagon deliveries at $4\frac{3}{4}$ cents per gallon. A heavier grade of oil would be still cheaper. Minor fluctuations in the price of diesel fuel will not materially change the comparison, since an increase of as much as one cent per gallon would increase the diesel operating costs only $854 per year. Larger fluctuations are most unlikely, the potential supply of oil being so large that it has been necessary to resort to legal limitations on production in order to hold the price to its present level. There is no danger of oil proration causing an excessive increase in the price of oil relative to coal. About one-half of the oil produced is sold in competition with coal, and consequently the price of oil cannot be artificially raised above the equivalent price of coal. The close correspondence between oil and coal prices is indicated by the chart on page 12 of *Power*, July, 1932.

Table 3 shows that whereas an all-steam power plant would have reduced the total yearly cost of steam and power from $88,100 to $71,800, a saving of $16,300, a combination power plant comprising two steam engines and one diesel would have effected a further drop to $66,900, or a net saving of $21,200 per year.

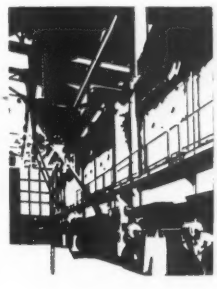


Table 1—Distribution of Steam in All-Steam Power Plant

	Steam for Heating, M Lb.	Kilowatt-Hours Generated	Steam for Power and Heat, M Lb.	Steam for Power Only, M Lb.
Winter:				
Dec., Jan., Feb., March..	42,580	816,000	46,852	4,272
Spring and Fall:				
April, May, Oct., Nov...	19,140	656,000	26,984	7,844
Summer:				
June, July, Aug., Sept...	2,340	572,000	18,320	15,980
Total for year.....	64,060	2,044,000	92,156	28,096

Table 2—Power Output & Fuel Consumption in Combination Power Plant

	Power Output, Kw.-Hr.			Steam for Power and Heat M Lb.	Diesel Fuel Gal.
	Steam Engines	Diesel Engine	Total		
Winter:					
Dec., Jan., Feb., March...	738,000	78,000	816,000	44,352	8,700
Spring and Fall:					
April, May, Oct., Nov....	416,000	240,000	656,000	19,268	22,900
Summer:					
June, July, Aug., Sept....	7,000	565,000	572,000	2,550	53,800
Total for year.....	1,161,000	883,000	2,044,000	66,170	85,400

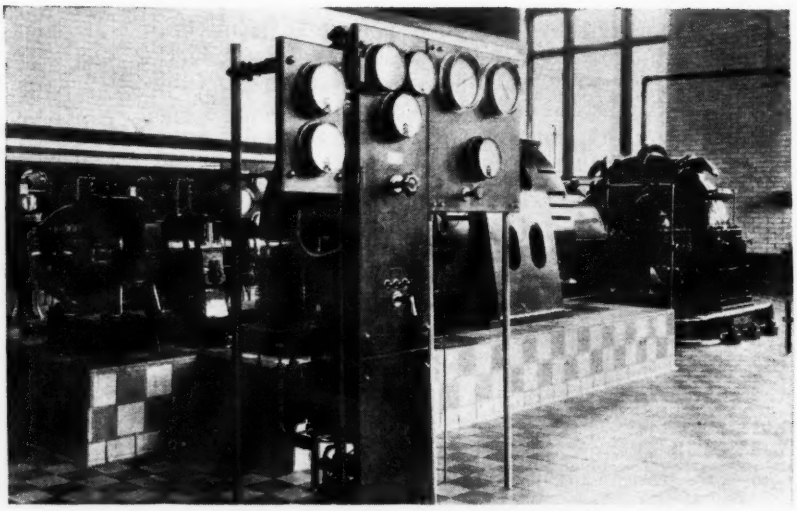
Table 3—Comparative Yearly Cost of Steam and Power

	Accepted Plan. Steam Generated Power Purchased	Eames Proposed Plan. Steam Generated, All-Steam Power	New Proposed Plan. Steam Generated, Diesel and Steam Power
Purchased power	$44,700	.....	.....
Coal	23,600	$33,300	$24,400
Diesel fuel, 5c. per gal	.....	.....	4,270
Labor — boiler room	8,700	10,200	8,700
engine room	.....	5,500	5,500
Boiler room maintenance	1,500	1,500	1,500
Engine room maintenance	.....	1,000	1,250
Insurance	200	400	430
Water, ash removal, etc.	900	1,200	900
Fixed charges	8,500	18,700	19,950
Total	$88,100	$71,800	$66,900

CORRECTION OF TROUBLES IN

CENTRIFUGAL PUMPS

By JOHN L. STEWART
Cleveland, Ohio



One of two 60-m.g.d., 312-ft. head pumps driven by 3,850-hp. synchronous motors

A CENTRIFUGAL pump is peculiar in that the conditions under which it operates depend to a large degree upon the intelligence of those who design and make the installation. It is sensitive to conditions differing from those for which it was designed. Therefore, the pump must be correctly selected for the service and be properly installed if successful operation is to be expected. If this is not done no amount of maintenance will enable the equipment to give good service.

One of the chief sources of trouble on a centrifugal pump is the suction, which is affected by several factors. First is the temperature of the liquid to be handled. For clear water at 80 deg. F. or less the suction lift on the pump intake should never exceed 21 ft. At 212 deg. a suction head of at least 12 ft. should exist at the pump intake as indicated on the curve. These are values that should prevail after allowance has been made for the losses in the suction piping and fittings.

For example, assume that the entrance losses to the suction pipe, the losses through the foot valve, in the piping and fittings and through the cut-off valve at the suction of the pump are estimated to be equivalent to 7 ft. of head. Then, if the water to be pumped will never exceed 80 deg. F., the maximum distance that the centerline of the pump may be placed above the intake level is not 21 ft., but 21 — 7, or 14 ft. If the water level of the suction varies, then the lowest level must be used and is the location from which the distance to the centerline of the pump must be measured.

The same reasoning applies where a static suction head is required on the pump. If the temperature of the water were to be 200 deg. F., then a static head of 5 ft. would be required at the suction of the pump. With losses in the suction piping and fittings equal to 5 ft. of head, then the free surface of the supply should be at a level of at least 5 + 5 = 10 ft. above the centerline of the pump.

Troubles with centrifugal pumps can be largely avoided if attention is given to suction and discharge piping design, and to the installation and operation of the equipment

Failure to take into account suction-pipe losses has been a common source of trouble, especially when the pump runs continuously and operates against a varying discharge head to supply an intermittent demand. If the head against which the pump is operating is suddenly reduced, the discharge may increase so rapidly that the pressure on the suction will be reduced below the vapor pressure point, unless proper account has been taken of the factors influencing the suction pressure.

The pump should, in all cases, be located as closely as possible to the source of supply and the suction pipe run with the minimum number of bends. Wherever it can be done, the pump should be so located that its centerline is below the surface of the source of supply. This makes it self-priming and removes one possible source of trouble.

Do not use pipe of a size smaller than the suction inlet to the pump. When the suction pipe is long or has a number of bends, use pipe one or two sizes larger than the suction of the pump. The piping should be laid out so that there are no bends where air pockets can form. Where there is a suction lift on the pump, and the pipe is not installed in a vertical position it should slope downward away from the pump and toward the suction well. If piping has a downward slope toward the pump, air pockets are likely to form and cause noisy operation and other troubles.

Whatever the conditions at the suction, care must be exercised to make all joints perfectly tight to prevent air leakage. Care should also be taken to see that the foot valve is not connected in a way that will prevent

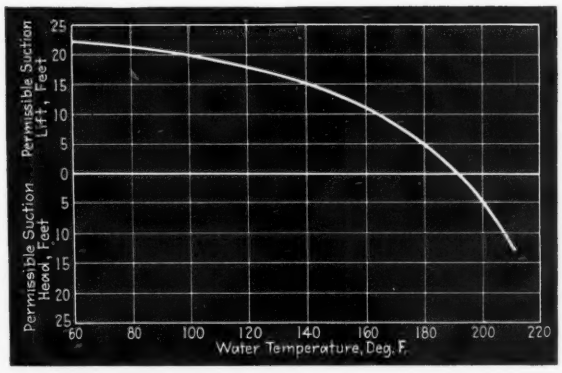
its functioning. Cases are on record where the pipe was screwed so far into the valve as to interfere with its proper operation.

The end of the suction pipe should always be at least three feet below the surface of the water, to prevent air being drawn into the pump. If this distance cannot be constantly maintained, a disk placed around the suction pipe just below the water's surface will assist in preventing air entering the suction. This disk should fit tightly around the pipe and extend out about 12 in. from it in all directions.

Where water containing so much air that there is danger of its interfering with operation, an air chamber may be placed at the pump suction and its top connected to a vacuum pump. The connection to the vacuum pump should be run up vertically 35 ft. to prevent the possibility of water being carried over into the vacuum pump.

What has been said about taking into consideration the losses when calculating the suction lift or suction head on the pump also applies to the discharge head.

The discharge pipe should be provided with a check valve to prevent the water from flowing back through the pump when stopped and running it backwards. This valve should be kept in good condition, since if it does not close immediately a severe water hammer may be produced in the pipe. Cases are on record where the check valve did not close until the water was flowing back through the pump at a high velocity. When the check valve did close and suddenly stopped the column of water, the water hammer was sufficiently severe to burst the pipe. In other cases, the pump and motor have been wrecked, due either to overspeed or to the float switch closing and connecting the motor to the line while it was running at high speed in the reverse direction.



Permissible suction lifts and head for pumps operating at sea level

On many of the larger-size pumps automatic or hand controlled valves are used to shut off the water in the discharge line when the pump is shut down. These valves are closed until the pump is running at full speed and are closed again before shutting the pump down. The use of such valves eliminates the danger from water hammer when shutting down and overloading when starting up.

Centrifugal pumps sometimes lose their priming and stop discharging even after they have been in successful operation. This is generally due to an accumulation of air in the top of the casing, the air being drawn into the pump through a leaky suction line or stuffing box.

In some cases the pump will operate satisfactorily when delivering full discharge but if throttled will lose its water. This is also caused by air leaks, but as long as the water is flowing through the pump at a high velocity the air is prevented from accumulating in the casing.

One of the causes for air leaking through stuffing boxes is clogged water seals. The trouble can also be caused by improper or worn packing.

Not infrequently trouble is experienced in keeping the stuffing box properly packed. Assuming that the type of packing used is correct, there are several mechanical causes for the packing failing to remain tight. Before packing can be expected to remain tight conditions at the stuffing box must be right.

The shaft must be smooth and run true, and the stuffing box must be concentric with the shaft. One cause of trouble with packings is an unbalanced and vibrating impeller. This causes the shaft to run out of true. The shaft may be bent or the sleeve on it may be eccentric. Although the shaft may run true at slow speed it may tremble and whip at high speed due to out of balance of the coupling or to the shaft being too light, or to something inside the pump pushing the shaft off the center about which it would normally rotate.

Improper alignment between the pump and motor or turbine may cause shaft vibration. Before the baseplate has been bolted and grouted to the foundation the pump should be carefully aligned with its prime mover. Metal wedges should be used under the bedplate to secure proper support and alignment. Natural flexibility of the average bedplate requires this and makes it desirable to wait until the grout has set before pulling down on the foundation bolts. Even when a flexible coupling is used between them there is no reason for neglecting correct alignment of the pump and its driver. A loose impeller or one that is rubbing on the diffusion rings may also cause the shaft to vibrate. Experience has shown that the pump shaft must run true to within 0.002 in. if packing trouble is to be avoided.

Other causes of packing trouble are the stuffing box out of round, a worn sleeve on the shaft, or the shaft running off center with the stuffing box due to worn bearings or other causes.

Causes of Noisy Operation

Noisy operation sometimes occurs. This frequently can be traced to air in the pump and can be removed through the air cock at the top of the casing. When turbine pumps are operated under heads less than they are designed for, the flow may be so distorted in the pump as to cause cavitation. At some point in the pump the pressure is reduced below the vapor pressure of the liquid and an air bubble is formed. When this bubble moves into a zone of high pressure it suddenly collapses and the resulting water hammer subjects the surface of the metal to a very heavy blow. This results in a breaking down and disappearance of the metal. Cavitation may also occur in pumps operating under their normal operating conditions if design is not suited to the service.

A vibrating shaft is another cause of noisy operation. In boiler-feed or other pumps handling high-temperature liquids if the suction head gets too low steam will be formed. This will be condensed when it reaches regions of higher pressure and will have the same effect as cavitation. It may also cause a rumbling noise in the pump. Where pumps are operated in parallel, some may not get their proper share of the water and will be noisy just as will a pump with its suction partly clogged.

Any attempt to improve hydro-plant efficiency must start with reliable measurements of water flow to turbines. Recent applications of piezometer orifices on stay vanes and in scroll cases have given satisfactory results. These methods are particularly useful in medium- and low-head plants

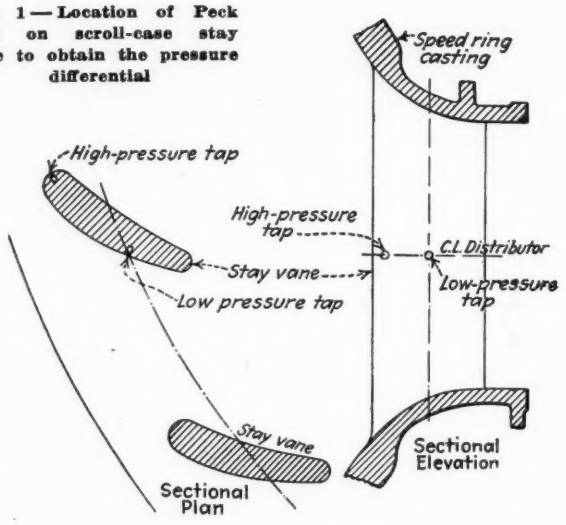


Fig. 1 — Location of Peck taps on scroll-case stay vane to obtain the pressure differential

2 METHODS OF MEASURING WATER TO

EVER increasing attention is being given to measuring the flow of water to hydraulic turbines. This applies both to acceptance tests and to regular operation. Where turbines are supplied through long penstocks, venturi tubes may be installed in them to provide the pressure differential to operate indicating and recording meters.

With many of the large units now being installed to operate under low or medium head, it is not possible to install a venturi tube section in the penstock. Even where it can be installed it may not be desirable because of the cost or for other reasons. Several attempts have been made to operate indicating and recording flowmeters from the differential pressure obtained across a change in section of the water passages to the turbine, with varying degrees. of success. Two systems that are receiving an increasing amount of attention are those known as the Peck method and the Winter-Kennedy method.

The Peck method of water measurement was developed by J. A. Peck for the New England Power Association and was originally for use in that company's Fifteen Mile Falls plant on the Connecticut River, recently renamed in honor of F. D. Comerford, President of the Association. The following description of this method is based on information supplied by Mr. Peck:

This method consists of two piezometer orifices located on one of the fixed stay vanes, or equivalent structural members, which serve as struts between the upper and lower halves of the distributor, or speed ring. The water passes between these stay vanes on its way from the spiral casing to the movable wicket gates and thence to the turbine runner. The velocity of the water in its passage between the stay vanes is at the highest value that can be conveniently utilized as a flow indicator, as the experiments showed. The stay vanes are located more or less in the direction of the stream lines, depending on the design of a given turbine.

The general principle is to locate one piezometer on the rounded leading edge of a selected stay vane and another on one side of the same vane (Fig. 1), or of another vane if conditions make this preferable. The pressure at the leading piezometer is less than the net static head by only the small percentage of velocity head not recovered by impact, while the pressure at the side piezometer is less than the net static head by its total velocity head. The pressure differential obtained is thus a high percentage of the velocity head at the vane and is proportional to the square of the velocity. Since good turbine design involves a uniform distribution of water entering the runner, it follows that the pressure differential should be proportional to the total flow, and this has been confirmed to date.

The Peck taps are now controlling eight electrically operated flow meters at the Comerford and McIndoes Falls stations on the upper Connecticut River. The Saluda hydro plant, of the Lexington Water Power Company, Columbia, S. C., is also equipped on four units, and two units at Safe Harbor were so equipped during field construction. The following will serve to indicate the differentials obtained in the first three plants, as well as in the experimental work at S. Morgan Smith Laboratory, York, Pa., by the New England Power Association and at Holtwood Laboratory by the Safe Harbor Water Power Corporation:

Location	Head, Feet	Flow, C.F.S.	Differential, Feet of Water
York Laboratory	10	15	1.48
Holtwood Laboratory	49	47	10.00
Fifteen Mile Falls	170	3,250	23.67
McIndoes Falls	28	2,000	7.83
Saluda	157	3,050	33.28

It will be noted that these maximum differentials range from 14 per cent to 28 per cent of the gross head. The differences are due to individual characteristics of turbine design as well as to location of the leading piezometer.

The Winter-Kennedy differential pressure taps utilize the pressure difference existing between the outer and inner walls of a turbine scroll case as a means of indicating the flow through the turbine. A typical installation is shown in Fig. 2. By use of this method a complete record of the performance of the unit can be obtained.

The fundamental principle of operation follows the spiral vortex law, according to I. R. Winter, hydraulic engineer, Birmingham, Ala., and one of the inventors of this method of water measurement. Suitable coefficients

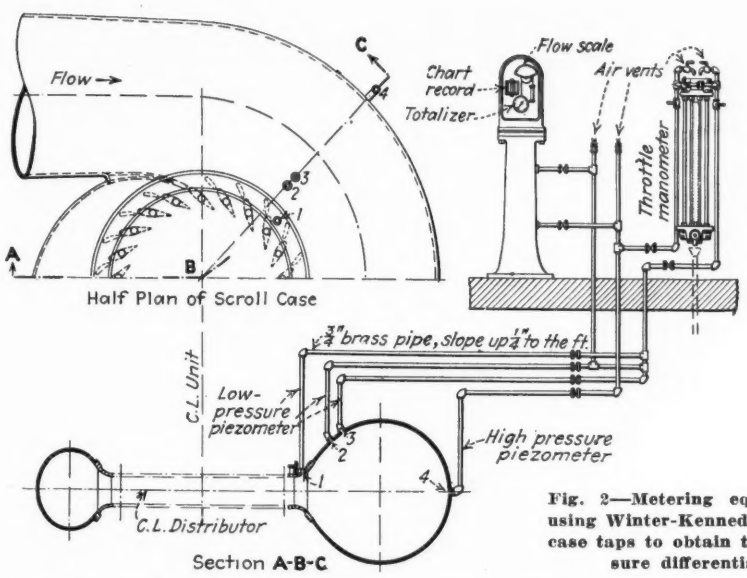


Fig. 2—Metering equipment using Winter-Kennedy scroll-case taps to obtain the pressure differential

HYDRAULIC TURBINES

can be applied and a very close approximation of the flow-meter performance can be predicted before the turbine is put into operation. By locating the inner or low pressure tap at various radii across the scroll, and at various cross sections around the scroll, a wide range of deflections can be had. Tests on a plant as shown in Fig. 2 indicated the following deflections, approximately.

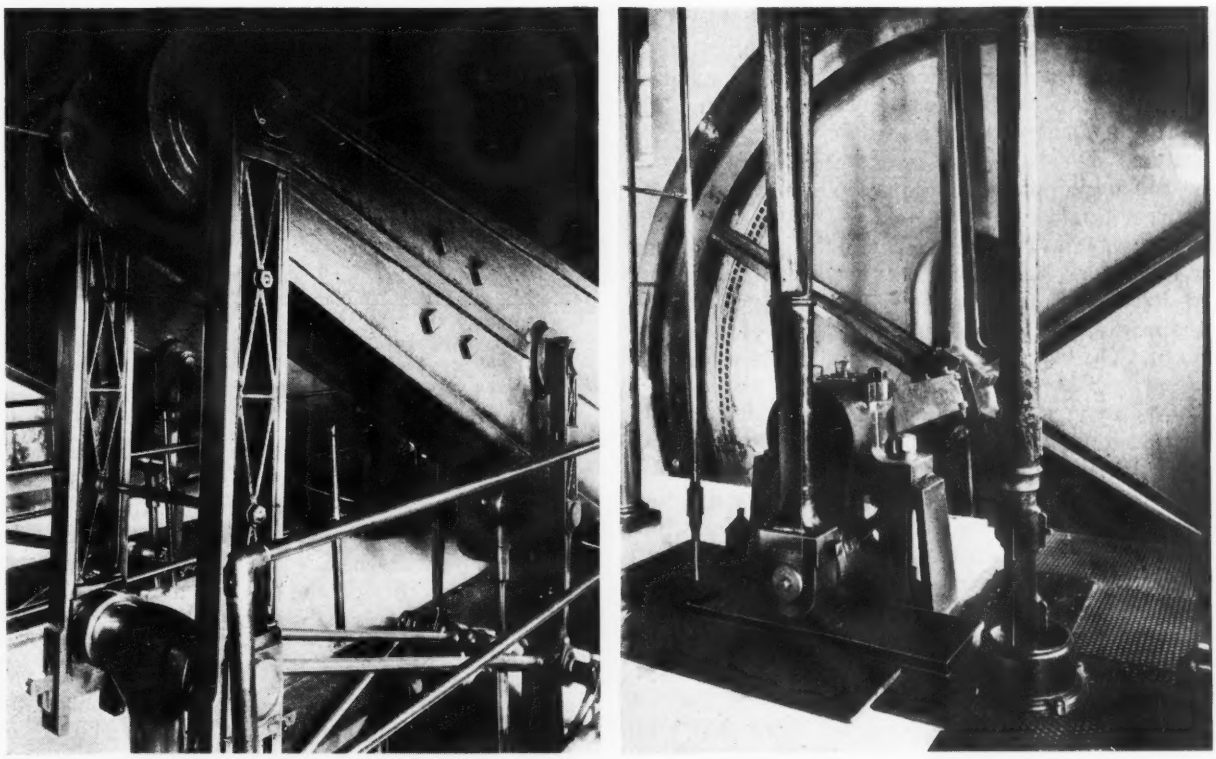
Piezometers 1 and 4; 21 in. mercury
Piezometers 2 and 4; 7 in. mercury
Piezometers 3 and 4; 6 in. mercury

with all taps giving a square-law relation of flow to deflection.

This method depends on the quantity of water flowing at the piezometer section. It is desirable that a large part of the total flow be passed through the section. This is essential as the influence of irregular operation of the turbine gates or a change in gate adjustment due to wear or link breakage has a decided bearing on the quantity-deflection relation obtained from the piezometer taps.

The differential taps, at the present stage of the art, cannot be located with sufficient accuracy to determine the rate of flow without first being calibrated by some reliable method of water measurement. The calibration, once having been determined, enables a valuable record of turbine performance to be had by use of a suitable water register. Thus the plant engineer can make hourly readings on the operating efficiency and check the kilowatt-quantity relation.

OLD ENGINES BUILT OF CAST IRON



This Boulton & Watt pumping engine at Deptford pumping station in England, according to Engineering (London), was built about 1812, has a beam about 26 ft. long by 4 ft. deep at the center and is made of cast iron. The connecting rods and flywheels shown on the right-hand photo are also of cast iron with the flywheel mounted on a square cast-iron shaft and held in place by eight wedges. A perforated cast-iron sector can be seen in the wall back of the flywheel that was used when barring the engine. With cylinders 36 in. in diameter and an 8-ft. stroke the engine was rated at 55.2 hp. and had been operated for 103 years when taken out of service. Photographs were supplied by the Metropolitan Water Board, London, England.

FLUE GAS HEAT LOSSES
When Oil Is The Fuel

By NEWTON C. EBAUGH
Georgia School of Technology

Most published charts for finding per cent heat loss have been for coal-fired boilers. These charts are designed for use with oil firing; one can also be used to check the accuracy of flue-gas analyses

HEAT losses when oil fuel is burned may be divided into two groups; radiation of heat from the furnace setting and heat carried out by the hot flue gases. The second is by far the greater in most instances.

Heat carried out in hot flue gases may be subdivided into three classes. First, there is a loss of heat because the dry flue gas leaves at a temperature higher than that of the incoming fuel and air mixture. Second, heat is carried out by the water vapor in the flue gas. Third, there is a loss of heat due to combustible gas. Combustible gas consists chiefly of carbon monoxide, and causes a large loss of heat. Some industrial furnaces must operate with CO in the flue gas in order to prevent oxidation of the product, but CO is usually highly undesirable. Carbon monoxide is usually caused by an insufficient air supply or a burner that does not provide sufficient turbulence for thorough mixing of the fuel and air. Incomplete combustion may also be caused by poor oil atomization. This latter may be due to a poorly designed burner, too low oil pressure, too low oil temperature or a dirty burner tip.

The best way in which to determine the correct amount of air to be used with a fuel, as well as the resulting combustion efficiency, is to analyze the flue gas with an Orsat apparatus. This analysis gives the per cent by volume of CO_2, O_2 and CO existing in the dry flue gas.

Flue Gas Analysis Chart

Only one combination of CO_2, O_2 and CO is possible for a given burner setting and draft when fuel oil is used. All possible combinations of these products for a typical heavy boiler fuel are shown in Fig. 1. The oil for which this chart is calculated is a 15-deg. A.P.I. (0.9659-sp. g.) fuel oil having the following ultimate analysis:

Carbon, (C)%	84.6
Hydrogen, (H_2)%	11.5
Sulphur, (S)%	1.6
Oxygen, (O_2)%	1.3
Nitrogen, (N_2)%	1.0
Heating Value, B.t.u. per lb.	18,800

This chart is nearly correct for all ordinary fuel oils, since the only change in the analysis is that the lighter oils usually have higher hydrogen and lower sulphur content.

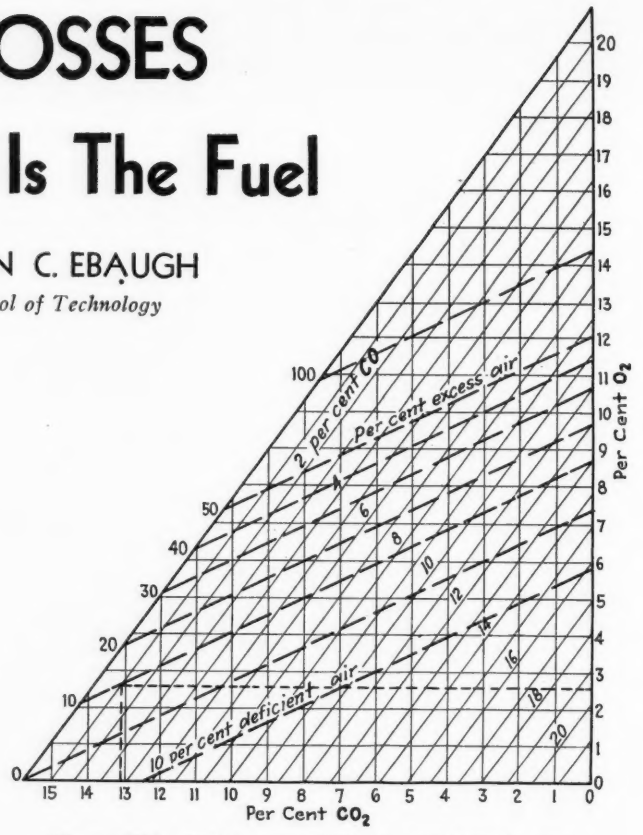


Fig. 1—This chart is convenient for checking the accuracy of an Orsat analysis of flue gas when burning oil

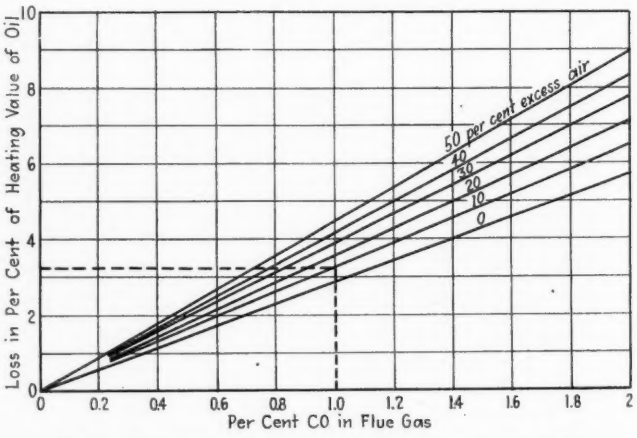


Fig. 2—Per cent heat loss due to CO in flue gas with various percentages of excess air

The flue-gas-analysis chart may be used as a check on the accuracy of the Orsat analysis. If the analysis shows 13.1 per cent CO_2 and 2.6 per cent O_2, then it must also show 1.0 per cent CO. The intersection of the 13.1 per cent CO_2 line with the 2.6 per cent O_2 line is shown on Fig. 1. This occurs on the 1.0 per cent CO line. Also, these values may only be obtained when 10 per cent excess air is being used, since the intersection is also on this line. It will be noticed that CO may appear when excess air is used. This condition may be due to poor atomization or poor mixing of the oil and air at the burner or to an insufficient air supply at the burner and subsequent air infiltration through the setting. Fig. 1 shows that when complete combustion is attained with 10 per cent excess air, there will be no CO, 14.3 per cent CO_2, and only 2.0 per cent O_2.

Carbon monoxide in the flue gas constitutes a serious loss of heat. Using the above condition of 10 per cent excess air and 1.0 per cent CO and referring to Fig. 2, it will be seen that 3.2 per cent of the heating value of the oil will be lost. Fig. 2 also shows that the loss due to CO increases with an increase in the excess air used. For instance, if 50 per cent excess air be used, the loss will be 4.5 per cent of the heating value of the oil instead of 3.2 with only 10 per cent excess air.

CO content of flue gas is hardest to determine accurately. However, if the CO_2 and O_2 are measured, the CO percentage may be taken from Fig. 1.

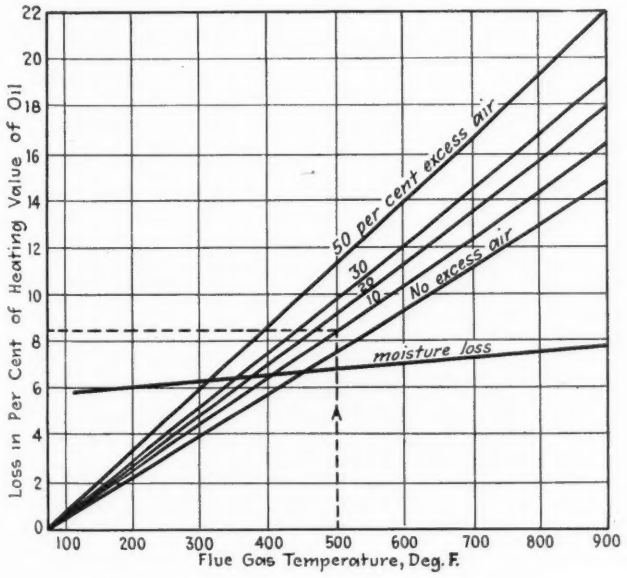
Loss due to Moisture in the Flue Gas

There are two sources of moisture in flue gas when oil is the fuel. First, the hydrogen content of the oil burns to form water vapor; second, the air supply contains moisture. The loss due to the moisture in the air supply creates a loss of the order of 0.2 to 0.3 per cent of the heating value of the fuel and is therefore usually included under the heading of "unaccounted-for" losses. However, the loss due to the moisture formed by the burning of the hydrogen is quite large and is shown on Fig. 3. It is seen that this loss increases slowly with increasing flue gas temperatures. This loss amounts to 6.9 per cent of the heating value of the fuel at a flue gas temperature of 500 deg. F., as shown in Fig. 3. The moisture loss is practically independent of the amount of excess air used, so that adjustment of the air supply will not affect it.

Loss due to Heat in Dry Gas Flue Gas

The dry gas creates a loss of heat due to the fact that it leaves at a temperature higher than the incoming air temperature. The amount of these losses is given by Fig. 3. It will be noticed that, unless the gas temperature is quite low, this loss will be the largest single loss. Also, Fig. 3 shows that this loss increases with increase in the flue gas temperature and with increase in the per cent excess air, for a given gas temperature. Hence, only two things can be done to lower this loss for a given installation. First, the excess air should be kept down to a small value by control of the draft but not so low as to cause excessive CO in the gas, and second, the heat-absorbing surfaces should be kept clean in order to secure the lowest flue gas temperature. For a gas temperature of 500 deg. and 10 per cent excess air, this loss is shown on Fig. 3 to be 8.3 per cent of the heating value of the oil.

Fig. 3—Per cent heat loss due to heat in dry gas and water vapor



Estimation of Boiler Efficiency

Suppose it were desired to estimate the efficiency of a boiler using 10 per cent excess air, with a flue gas temperature of 500 deg. and where 1.0 per cent of CO appears in the gas. The losses will be as follows:

	Per Cent
Loss due to CO, from Fig. 2	3.2
Loss due to moisture, from Fig. 3	6.9
Loss due to dry gas, from Fig. 3	8.3
Radiation and unaccounted for, estimated	2.0
Total loss	20.4

The over-all boiler and furnace efficiency will be 79.6 per cent.

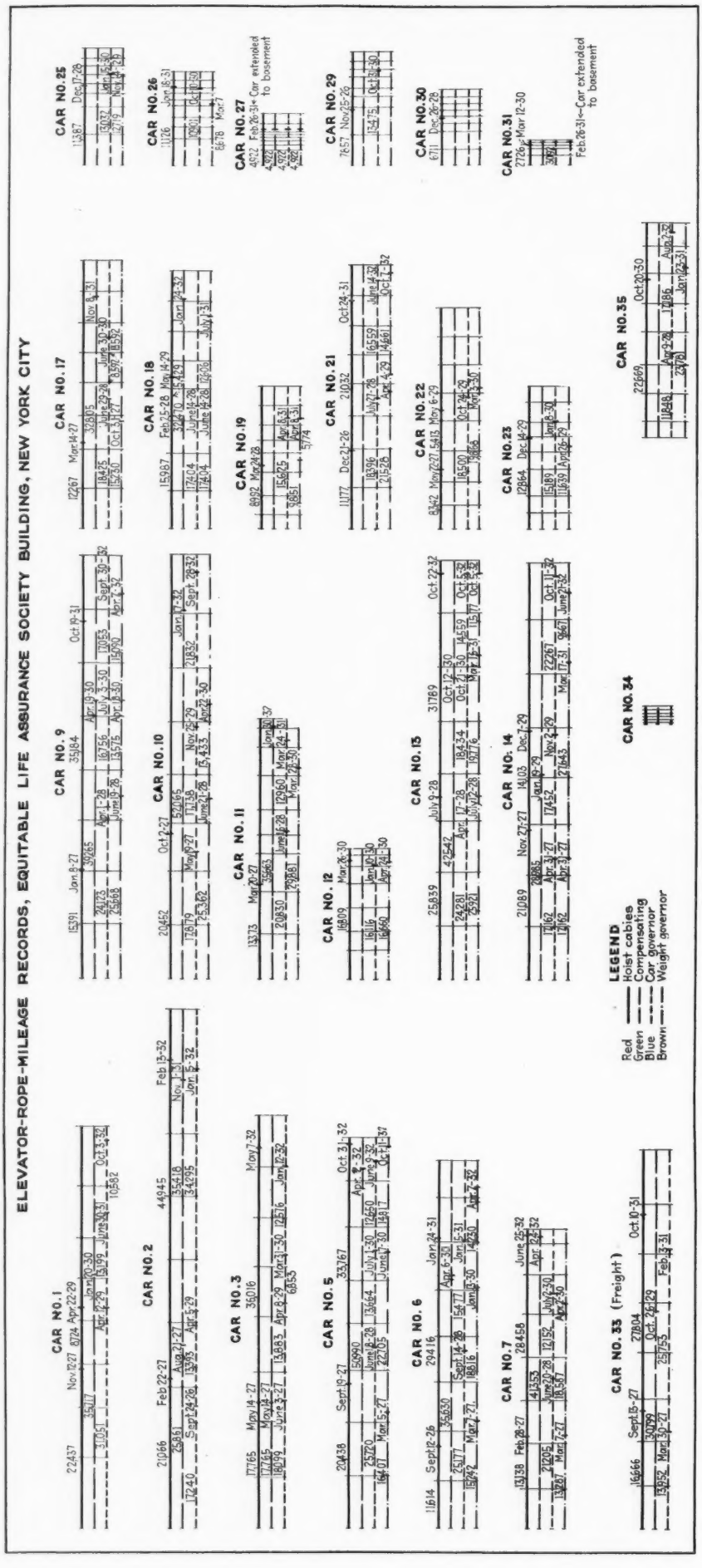
Record High-Head Impulse and Francis WATERWHEELS

Plant Name	Country	No. of Units	Type	Rated Horsepower	Effective Head, Ft.	Static Head, Ft.
Fully	Switzerland	4	Impulse	3,000	5,350	5,425
Niederenbach.	Switzerland	2	Impulse	11,450	3,260	3,560
Feather River	Calif., U.S.A.	2	Impulse	35,000	2,368	2,561
Vermunt	Austria	4	Impulse	33,250	2,350	....
Big Creek 2A.	Calif., U.S.A.	2	Impulse	56,000	2,290	2,420
Balch	Calif., U.S.A.	1	Impulse	40,000	2,243	2,381
Serra	Brazil	2	Impulse	40,000	2,230	2,380
Fusenko	Korea	4	Impulse	45,625	2,182	....
Zappello	Italy	2	Francis	5,000	1,152	....
Bringhausen	Germany	4	Francis	40,500	975	1,000
Vemork	Norway	1	Francis	17,500	918	950
Oak Grove	Ore., U.S.A.	2	Francis	40,000	850	935
Brommat	France	3	Francis	42,500	840	....
Waterville	N. C., U.S.A.	3	Francis	49,000	755	860

THIS table lists some of the outstanding impulse- and francis-type waterwheels in the world. The Fully project in Switzerland heads the list with an effective head of 5,350 ft. These four units have a rating of only 3,000 hp. each and were put into operation in 1914. The largest impulse units are the two 56,000-hp. machines in the Big Creek 2-A plant of the Southern California Edison Company that operate under an effective head of 2,290 ft. These wheels on test developed 70,000 hp. and are of the double-runner overhung type, with one nozzle per wheel. For a single wheel with one nozzle the four units in the Vermunt plant in Austria probably hold the record for capacity, each being rated at 33,250 hp. under an effective head of 2,350 ft.

For Francis-type units the two 5,000-hp. turbines in the Zappello plant, Italy, are operating under the highest effective head, 1,152 ft., for waterwheels of that type. In Germany, the four 40,500-hp. turbines in the Bringhausen plant, which operate under a 975-ft. effective head, can probably be classed as the most outstanding units in the world of the Francis type. Ranking next to Bringhausen are the two 40,000-hp. units in the Oak Grove plant of the Portland Pacific Northwest Public Service Company in Oregon, that operate under an effective head of 850 ft. The first of these units was put into operation in 1924, while the Bringhausen units began service in 1931.

CHART SHOWS ELEVATOR



IN THE Equitable Life Assurance Society's building, New York City, a complete record is kept of elevator performance, as well as of all other functions of building operation. There are a total of 27 elevators, 24 of which are for passenger service, one is for freight service and the remainder are special elevators. Of these elevators, 25, including the high-rise freight, are of the double-wrap, gearless, traction type, with one-to-one roping and a car speed of 600 ft. per min. Three of the express elevators rise 368 ft., nine 321 ft., the freight 394 ft. and the 12 local passenger cars rise 170 ft.

Each elevator is equipped with a watt-hour meter, a stop counter and a mileage recorder. Daily readings are taken of the power consumption, the car mileage and the number of stops for each elevator. From these readings a daily report is made.

The cumulative records of car mileage are of great importance, as these show the life of the ropes. Up until recently these were kept in tabulated form. To simplify record keeping and at the same time make them more easily interpreted, R. Pryor, chief elevator mechanic, devised the system of presenting them graphically, as in the figure.

Each group of lines represents the ropes on one elevator. The full line is the hoisting ropes, the dash line the compensating ropes, the dotted line the car-governor rope and the dot and dash line the counterweight-governor rope, when this governor is used. On the actual graphs a system of colored lines is used, the hoisting ropes being shown in red, the compensating ropes in green, the car-governor rope in blue and the counterweight-governor rope in brown.

A scale of 0.1 in. per 1,000 mi. of rope life has been adopted. Thus 10,000 mi. of rope life are represented by a 1-in. line. At 3-mo. intervals the mileage-counter readings are compared and the graphs extended to bring the mileage record up to date. After the daily mileage records have served their purpose in compiling the daily report they may

MANY YEARS OF ROPE LIFE

be destroyed and the work of keeping them in permanent form is thus avoided.

The mileage counters read to 10,000 miles and then again start from zero. By keeping a record of what the mileage counter reads, when the ropes go into service, a check can always be made with the counter at any time after, to see that a mistake has not been made. When a set of ropes is replaced, the total mileage of the old ones is put on its graph and a short vertical line drawn at the end of the graph to indicate the place in the record where the change was made.

For example, the first set of hoisting ropes on No. 1 elevator had a life of 22,437 mi. These ropes were changed on Nov. 12, 1927. Assuming the mileage recorder to be set at zero when it went into operation, the difference between 22,437 and 20,000 or 2,437 was the reading of the recorder at the time when the ropes were replaced.

The second set of hoisting ropes failed prematurely. They had a life of only 8,724 mi. and were changed on April 22, 1929. The total car mileage on that date was 22,437 + 8,724 = 31,161 and the recorder's reading was 31,161 — 30,000 = 1,161. This value is available at any time to check the graph of the next set of ropes, if at any time there is any doubt as to a mistake being made in scaling off the life of the ropes. At the end of each year when the record of rope life is brought up to date, a light vertical line is drawn across the three or four graphs to indicate the yearly period.

The chart is mounted in a frame and hung on the wall of the chief elevator mechanic's office where it is available for ready reference. As previously mentioned, the life of ropes that have been replaced is given on the graphs. The life of the ropes in use can be readily determined by scaling off the length of the line representing their mileage to date.

It will be noticed that sets of hoist rope placed in service since 1927 have a much longer life than the first sets. About that time the hoist ropes were equipped with automatic equalizers, and increases in rope life up to 130 per cent over the previous sets have been obtained. There are two or three cases where the second set of hoist ropes shows unusually short life. This is the result of a change to a design of rope apparently not suited to these elevators.

The absolute futility of attempting to get an idea of rope life by a record of the time they are in service is evident from the graphs. Elevator No. 2 has a mileage record of about 75,000 miles, while elevator No. 34, which is special and in service for only a short time each day, has only gone about 5,000 miles in the same period. Even in the same bank, elevators may have a wide variation in mileage. An illustration of this is found in elevators Nos. 9 and 12, the former having traveled about three times as far as the latter. These cars are in the same class of service.

There are many factors that affect the life of elevator ropes, one of which is the length of travel. It will be noted that the life of the high-rise express elevator ropes, cars Nos. 1 to 14, is in general considerably longer than the life of the ropes on the low-rise local elevators, Nos. 17 to 31. This is easily accounted for in the smaller number of times the ropes are bent and the fewer stops per car-mile for the high-rise cars.

CREEP OF METALS

Measured in Millionths of an Inch

WHEN hot, metals slowly yield under a steady pull, so P. G. McVetty of the Westinghouse Research Laboratory patiently investigates this high-temperature creep. Automatically held at exact temperatures in individual furnaces, various samples carry heavy loads for months, while sensitive instruments indicate changes of a millionth of an inch. Curves are plotted and the alloys best suited for turbine blades are then selected. Today, steam turbines attain peripheral speeds at the blade tips of 15 mi. a min. and operate at temperatures over 800 deg. F.

The testing for creep of steam-turbine materials represents the highest order of sensitivity and accuracy in all details of the testing procedure. To measure creep rates of this order of magnitude requires not only the measurement of extremely small length changes but precise measurement and control of temperatures.

While the creep test is the best known means of predicting the value of a material for high-temperature service involving small permissible deformations, its limitations must not be ignored. At best, the length of a creep test is small compared to the time during which a material is expected to give satisfactory service. Extrapolation of creep curves is necessary but great care is essential if large errors are to be avoided.

It is generally agreed that creep is affected by the previous history of the material, especially in the case of alloys which exhibit age-hardening tendencies. We may have, for example, a creep test in which the measured creep rate is negative because some structural change completely hides the creep. A more dangerous case is the one in which the creep is reduced to a small value during the test by age hardening. In this case the danger lies in the probability of an increased creep rate after the maximum age-hardening effect is passed in service.

Neither the designer nor the testing engineer can extrapolate the creep curves with accuracy if internal changes in the metal are proceeding during the test and in subsequent service. This gives to the metallurgist a real problem in producing alloys which are not only resistant to creep but also structurally stable under service conditions of stress and temperature during the service life of the material.

UNIT SYSTEM
Cools Large Dallas Store

NEIMAN MARCUS Style Shop, Dallas, Texas, occupies a 4-story building with ground area of 20,680 sq.ft. and an adjoining 2-story building with ground floor area of 2,600 sq.ft. Excepting the basement, which is not used for sales purposes, the entire area of the store is cooled and dehumidified by unit-type coolers. Fifty unit coolers of the overhead type were suspended in various locations throughout the building to give uniform air distribution, particular consideration being given to locations that would not in any way interfere with the decorative arrangement of the salesrooms.

The system was placed in operation last year and operated during the 1932 summer. Its performance is shown by the record of temperatures in the table. Conditions existing at the time the 3 o'clock readings were taken were almost the exact maximum conditions for which the system was designed. Temperatures secured in all of the individual rooms were better than expected for these outside conditions. Comparisons of these room temperatures with the comfort chart published in the 1932 A.S.H. and V.E. Guide shows that an average of 84.8 per cent of theoretical perfection in human comfort was maintained.

The store had been remodeled a short time previous to the air-conditioning installation and formed one of the most beautifully appointed style shops in the country. The dictum was laid down that these display rooms were not to be marred by the installation of any duct work, either for distribution of air in these rooms or by ducts passing through them for distribution of cooled air to other rooms. The unit air conditioner was the only type that could be used for this installation without in any way interfering with the interior decorative effect of the salesrooms and was the main reason this equipment was chosen. Fortunately, use of the unit system entails no sacrifice of air-conditioning efficiency.

Workrooms, stockrooms and closets were adjacent to the display rooms to be conditioned and these made ideal places to locate the air-conditioning units. Piping required for distributing the cooling fluid to the unit conditioners could be installed with a minimum of cutting and patching.

Fig. 1—Arrangement of refrigeration equipment

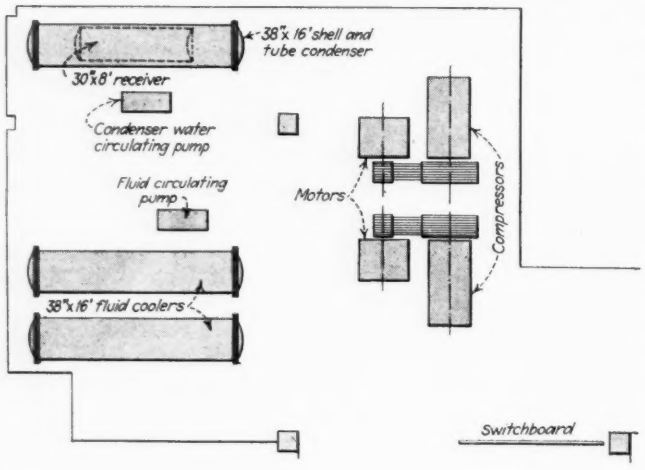


Fig. 3—Typical installation of a unit. The door leads into a closet in which the unit is suspended over the door shown, conditioned air entering the display room through the upper grille

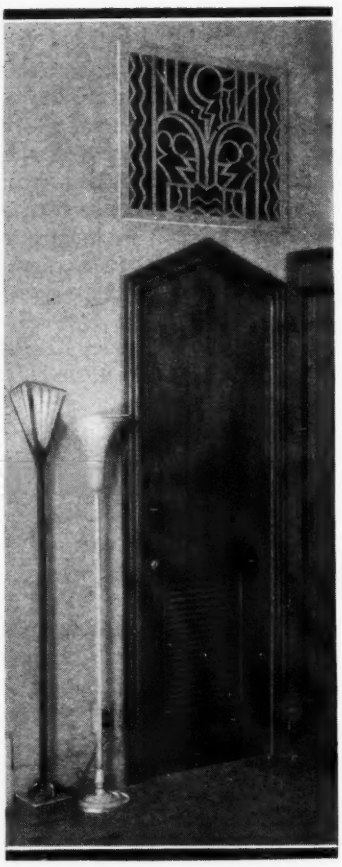
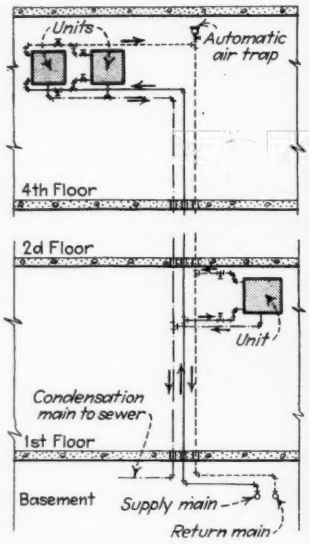


Fig. 2—A typical riser arrangement and the method of connecting the units



The unit conditioners have fin-type U-tubes of copper, with cast-iron side headers having supply and return fluid chambers. Aluminum-blade propeller fans are direct-connected to variable-speed motors in each unit. The units are supported in a heavy interior galvanized frame and inclosed by a pure copper housing which is insulated on the inside to prevent sweating. To collect moisture which drips from the cold tubes, a copper pan is concealed inside the unit. A series of vertical vanes between the louvers and coils prevents free moisture being blown off the tubes into the room. A cross-section of the unit is shown in Fig. 5.

With outside conditions of 100 deg. dry bulb and 78 deg. wet bulb, the system was designed to produce a mean temperature drop of 12 deg. throughout the conditioned area. To obtain these results, the cooling medium must enter the unit at 35 deg. To guard against the possibility of freezing in the liquid cooler, and also to provide flexibility for extreme weather conditions, a special non-freezing liquid is used, in combination with water, as the cooling medium, which allows lowering the

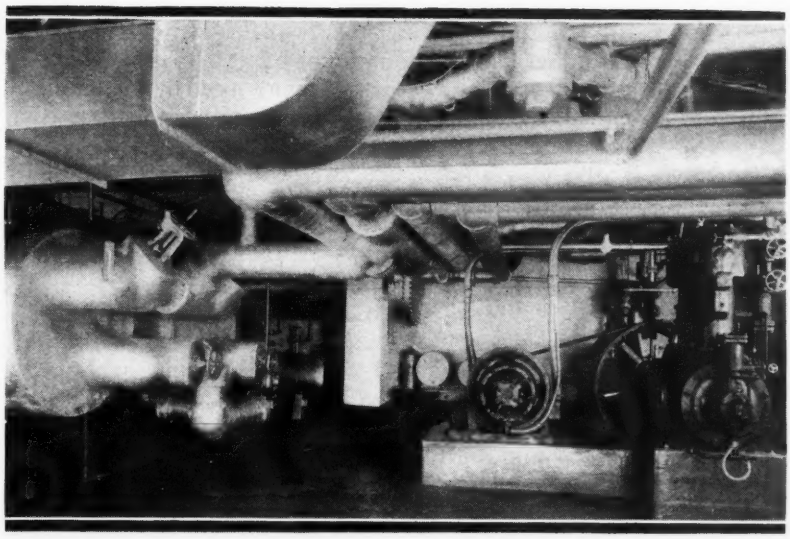


Fig. 4—The refrigeration installation, showing the ammonia compressor at right and the fluid coolers at left

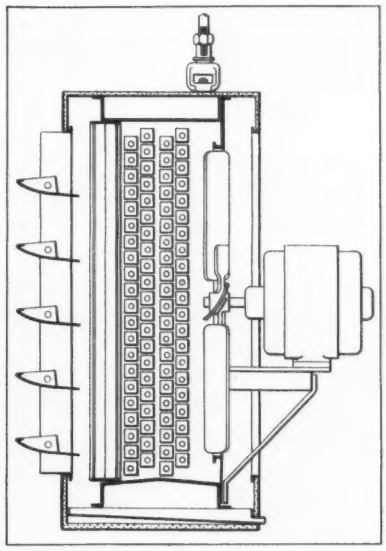


Fig. 5—Cross-section of a typical air-conditioning unit

temperature to 20 deg. F. This permits greatly accelerating the dehumidification when the outside wet bulb temperature may be unusually high. A 10-deg. rise in fluid temperature is allowed while passing through the unit, which is somewhat greater rise in temperature than customary in the brine circulation systems of refrigerating plants. However, it was determined that this would provide an economical design because of the smaller pipe sizes required and the lower pumping costs incurred.

The schematic diagram, Fig. 2, shows a typical riser arrangement and the method of connecting the units. It should be pointed out that these same units can be arranged for heating by the addition of a heat exchanger. The fluid-circulating pump used during cooling can be used for heating. This was not done in this store because the heating system originally installed functioned satisfactorily. The size of the units installed for cooling provides considerably more capacity than would be required for heating, consequently the temperature of the circulating fluid in winter need not be more than 150-deg. average during zero weather. Under these conditions air leaving the units would be at about 100 deg.

The arrangement of the refrigerating equipment for cooling the special fluid is shown by the plan, Fig. 1. It consists of two 115-ton, 10x10-in. vertical ammonia compressors, belt-driven by 125-hp. synchronous motors. The ammonia vapor is condensed in a 38-in. x 16-ft. shell-and-tube horizontal condenser. Condenser circulating water is cooled by a cooling tower on the roof of the 4-story building. There are two fluid coolers, each 38 in. x 16 ft. Total connected motor load of the refrigerating system is 355 hp. During the weather conditions indicated by the 3 p.m. readings in the table, less than 80 per cent of the total motor horsepower was being used.

The ammonia compressors are provided with automatic starting and stopping control which maintains a predetermined temperature of the fluid leaving the coolers. The operator sets the temperature control according to outside weather conditions.

Closer room temperature control is obtained by hand regulation of the fan speed on the individual units. The capacitor-type motors are provided with a choice of eight speeds, only three of which are connected for hand control. Choice of eight fan speeds was provided so that the capacity of each unit could be finely adjusted during installation to meet load requirements there.

As previously mentioned, the units were in most cases suspended in stock rooms or closets adjoining the conditioned space and connected to wall supply grilles by fibre-board transition ducts. The supply grilles were all located near the ceiling and recirculating grilles near the floor and leading to the stock room or closet in which the unit is located, but usually no connection was provided between the return grille and the unit. This is important because duct connections to both inlet and outlet of the unit would amplify any small noise in the unit.

Fig. 3 shows a typical installation of a unit in a closet adjacent to a display room. The unit is suspended overhead and discharges conditioned air through a grille above the closet door. A grille in the bottom panel of the door permits recirculation air to enter the closet.

Except in one room the system is designed for air recirculation only, the natural air change inherent in buildings of this type being depended upon for ventilation. The one exception, for which mechanical ventilation is provided to assist in economically overcoming a heavy lighting load, is the so-called Hexagon Room, where crystal and silver ware is displayed.

Outside Temperature		Time—9 A.M. 84° D.B.–73° W.B. Inside Temperatures				Time 3 P.M. 98° D.B.–75° W.B. Inside Temperatures			
	Department	Dry Bulb	Wet Bulb	Rel. Hum. Per Cent	Per Cent Comfort Zone	Dry Bulb	Wet Bulb	Rel. Hum. Per Cent	Per Cent Comfort Zone
First Floor	Shoe dept.	76	65	55	96	79	66	50	84
	Main St. entrance	76	65	55	96	80	67	50	70
	Glove dept.	76	64	51	98	79	66	50	84
	Men's shop	77	66	55	90	80	67	50	70
Second Floor	Sports wear	76	65	55	96	79	66	50	84
	Ladies' wear	77	66	55	90	79	66	50	84
	South French rm.	75	64	54	96	78	65	49	89
	Coat dept.	78	67	56	84	79	66	50	84
	North French rm.	76	65	55	96	77	65	52	94
	Tailor shop	77	66	55	90	78	65	49	94
Third Floor	Corset dept.	78	66	52	86	80	67	50	72
	Younger set dept.	78	66	52	86	80	67	50	72
	South French rm.	76	65	55	96	79	66	50	84
	Hat dept.	78	66	52	86	79	66	50	84
	North French rm.	78	66	52	86	78	66	52	84
Fourth Floor	Chintz room	77	66	55	90	78	65	49	90
	New Orleans rm.	78	67	56	84	78	65	49	90
	Gift shop	78	67	56	84	78	65	49	90
	Hexagon rm.	76	65	55	96	77	64	48	96
	General Office	78	65	49	90	78	64	46	94
	President's Office	78	66	52	86	78	66	52	89
	Rest room	78	67	56	84	78	67	56	84
	Aver. store temp.	77	65.6	54	90	78.5	65.7	50	84.8

ENTHALPY

WHAT IS IT?

By J. H. POUND

Professor of Mechanical Engineering, The Rice Institute

"ENTHALPY—what is it?" A proper enough question for almost any of us to ask, because after all enthalpy wasn't heard of until five or six years ago. But now that the word is beginning to appear with increasing frequency in technical papers, steam tables and thermodynamic texts, it will probably pay us to know what it's all about. True, use of the word is accompanied once in a while by a definition or an equation, but usually the additional information is too brief and too "highbrow" to be very helpful or illuminating. None of the dictionaries list the word; only the most recent thermodynamic texts are of any help. Most younger graduates of engineering schools understand the word, for they have dealt with it in classwork, but plenty of the older men have never seen these texts.

The bald definition of enthalpy is: internal energy plus $\frac{144pV}{778}$, in which p is absolute pressure, lb. per sq.in. and V is specific volume, cu.ft. per lb. Its unit is B.t.u. per lb., and its synonyms are "total heat" or "heat content." Many steam or refrigerating engineers will at once think that enthalpy is simply a new and fancy name for a steam table or ammonia table quantity with which they are quite familiar, and they will be partly correct. The quantities listed in American vapor tables as total heat of saturated and superheated vapors meet the definition of enthalpy given above, and some publishers of these tables mention enthalpy as an alternate name.

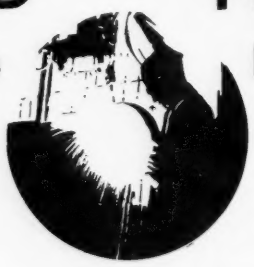
But to stop with this statement would be misleading. Enthalpy is a term applicable to other conditions than saturated and superheated vapors, and it appears under other names than total heat. It can be figured for gases and liquids as well as for vapors. The heat of the liquid for saturated water as read from steam tables is enthalpy. In problems involving the energy content of boiler feedwater at temperatures lower than the boiling point corresponding to a very high boiler pressure, engineers are accustomed to figure a different quantity, which could properly be called enthalpy. Whether it is enthalpy of subcooled water or of superpressure water is debatable, but at any rate its energy content fits the definition of enthalpy. And since part of this energy content is not heat energy, such names as "heat of the liquid" or "heat content" seem unappropriate.

In the study of gases, many opportunities for confusion arise through the use of expressions like "heat content" or "total heat." As ordinarily applied, they mean the sum of the internal energy of the gas (a quantity dependent on temperature and properly expressed in B.t.u.) and on the ability of the gas to do work (an energy quantity dependent on the gas pressure). This sum may represent total energy under some conditions, but that part of it dependent on pressure is not energy in the form of heat. To prevent the misunderstandings possible when the word "heat" is used to include other forms of energy, a special word associated with an exact definition can serve a useful purpose.

Who first proposed the word enthalpy for this purpose, I do not know. Its origin is apparently the Greek word *enthalpo,* meaning heat, a word which should be accented on its second syllable. So far as I can learn, the only authors to express a preference are Kiefer and Stuart, who accent the second syllable.

WELDED PIPING

As Welders Look At It



WIDER application of welded piping for power work was urged in a recent joint meeting of the American Welding Society, New York Section, and the Metropolitan Section of the A.S.M.E.

Robert Daniels, of the General Electric Co. (in a paper read by Mr. Hutchins of the same organization) declared that arc-welded piping, fabricated with coated electrodes, is particularly suited for such work because of the high ductility and strength of the joint. He described the welding of the long 14-in. mains which will carry steam from the new $4,000,000 mercury steam power plant to the G.E. factory in Schenectady.

He recommended the use of chill rings inside to prevent the formation of icicles within the pipe. About four months in all is required to train a good pipe welder, according to Mr. Daniels.

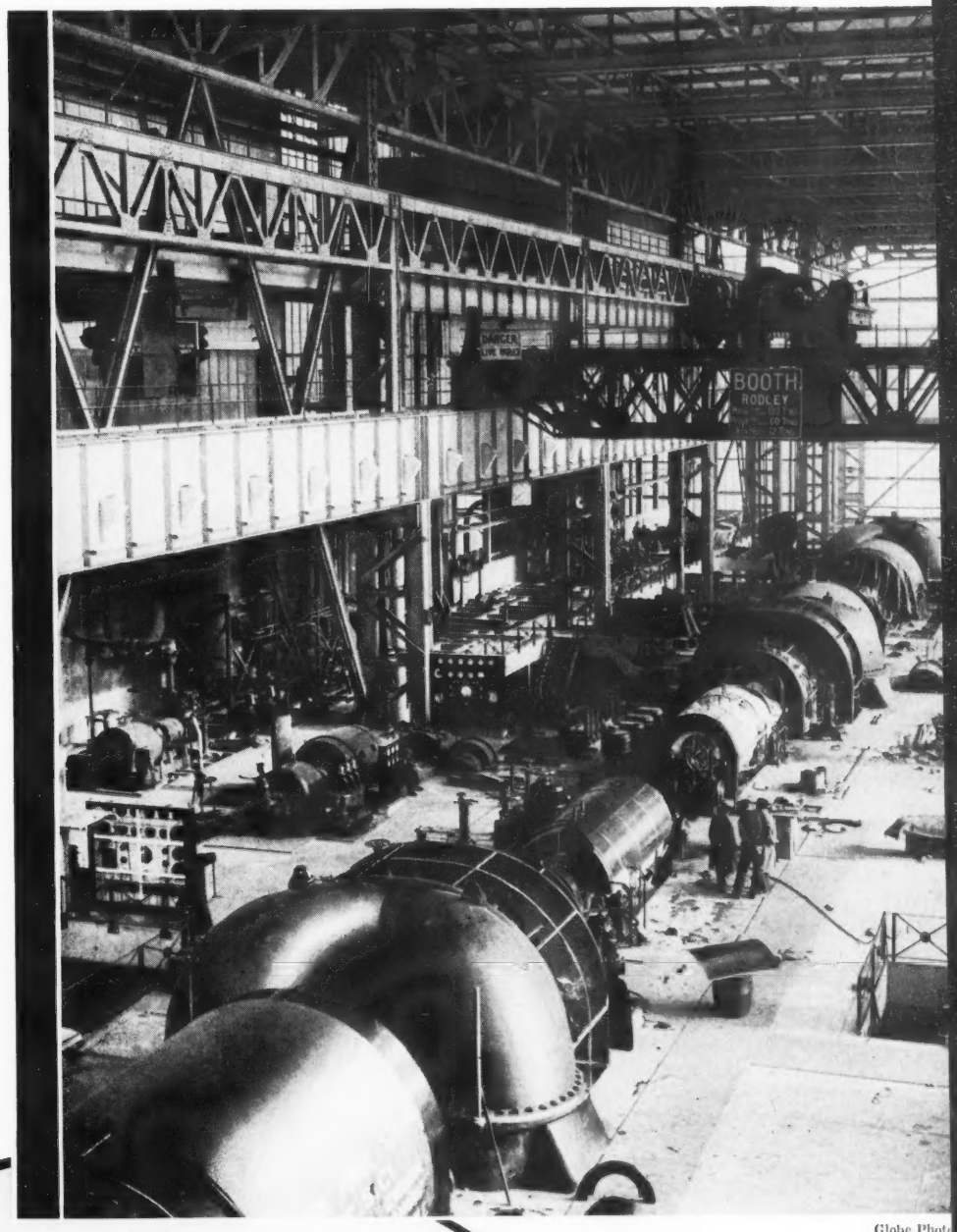
S. Lewis Land, educational director of the Heating and Piping Contractors National Association, said that pipe welders must in general be developed from the ranks of union steamfitters—in short, that pipe welding must be part of the steamfitter's trade.

Many arguments for the use of welding fittings were presented in a paper by F. S. G. Williams, of the Taylor Forge & Pipe Works. He urged the designers of piping systems to design completely for welding, and to specify the details of procedure. He stressed the importance of careful qualifications of welders. Mr. Williams gave the result of water-flow tests, showing considerably lower pressure drop through welding ells than through screwed ells. He recommended that all welding bevels, as far as possible, be machine cut.

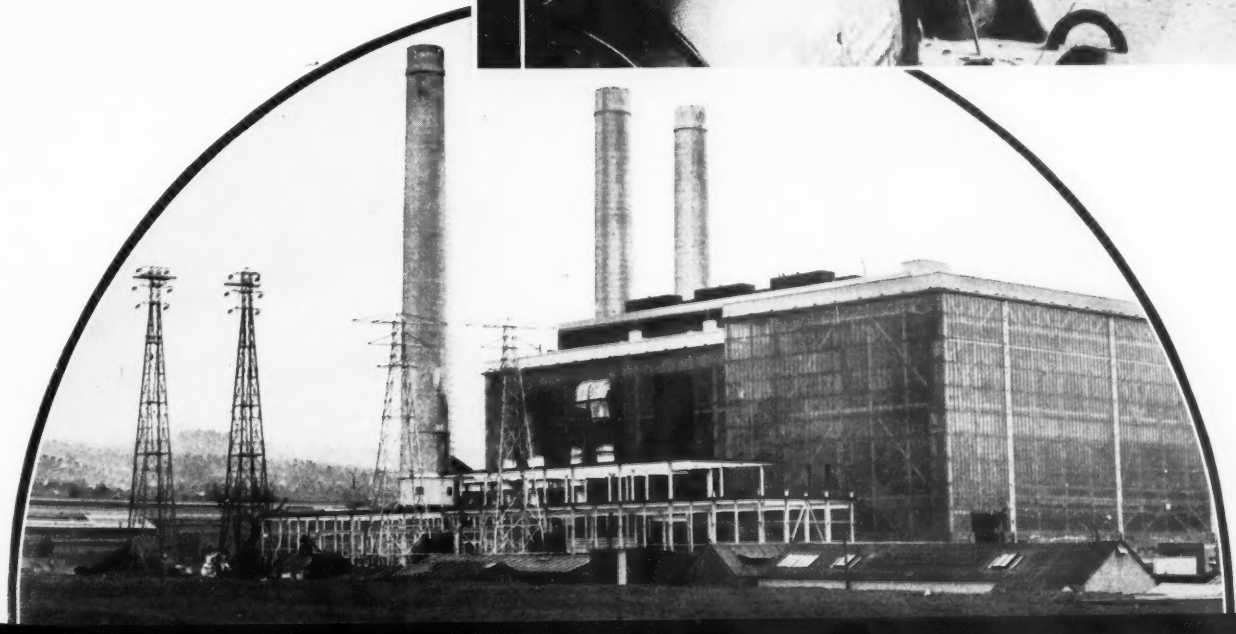
Mr. McKee, of M. W. Kellogg Co., described welding of main steam lines (15 x $1\frac{9}{32}$ in.) to operate at 750 lb. and 860 deg. F., in Burlington (N. J.) Station.

150,000 KW.
for BRITAIN'S GRID

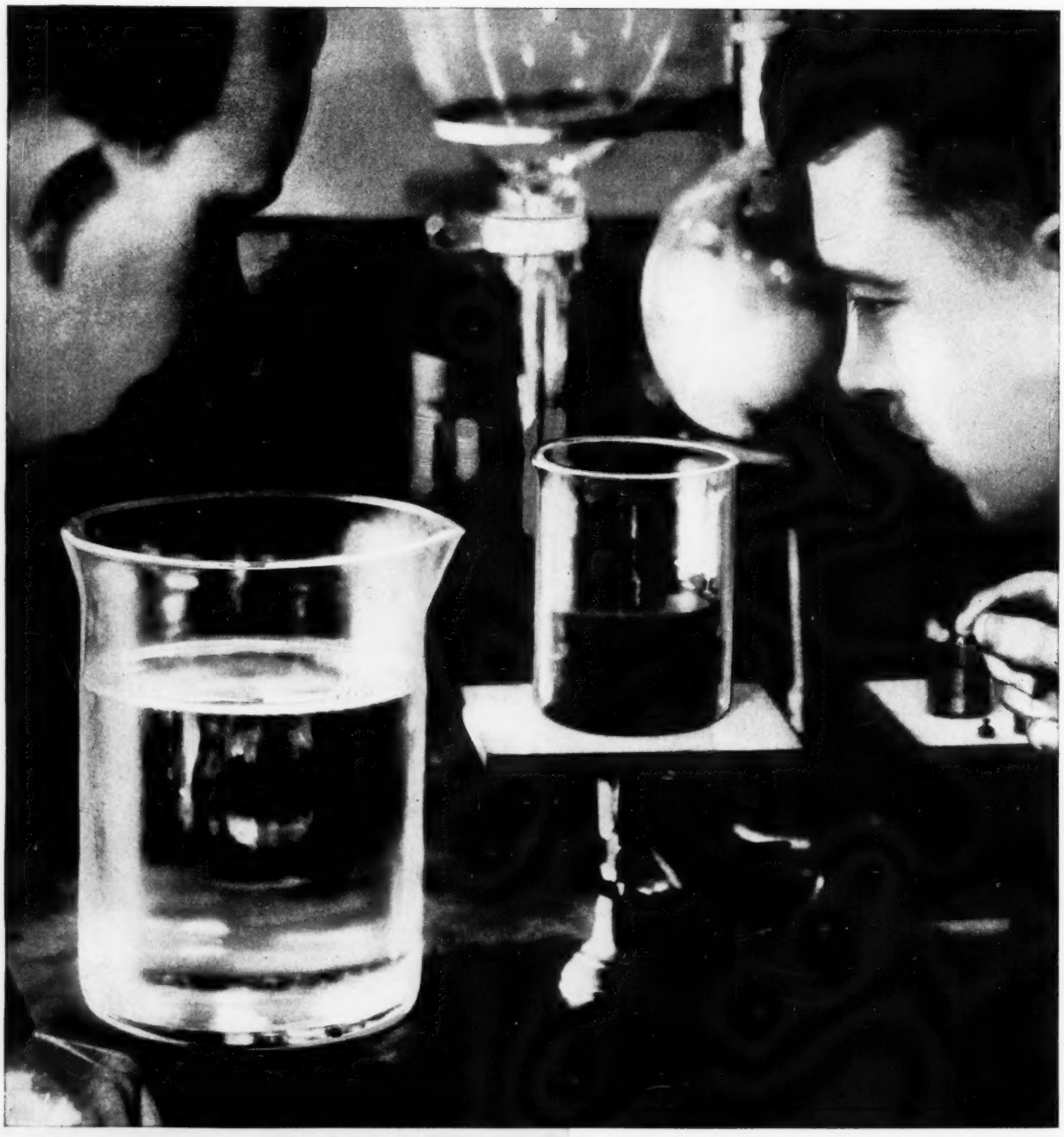
• SOLID GLASS WALLS house the new 150,000-kw. Dunston B station, part of the Central Electricity Board North-East System in England. On the banks of the Tyne at Newcastle, this plant contains three 50,000-kw. Parsons turbo-alternators. These turbo-alternators, the last with which Sir Charles Parsons was concerned before his death, are tandem, 2-cyl., reaction turbines, driving alternators at 1,500 r.p.m. Steam pressure is 600 lb., temperature 800 deg. F.



Globe Photo



13.3% *Impurities*



What this RE-*refining* test showed

TESTS	SUBMITTED SAMPLE (100%)	PURIFIED OIL (86.7%)	UNSTABLE EXTRACT (13.3%)
Gravity	27.8	30.8	11.8
Viscosity at 100° F.	150	134	520
Viscosity at 210° F.	43½	43	52
Percentage Carbon Residue	0.01	0.01	0.12
Oxidation Number	29	12	220

* **RE-*refining* of competitive oils by Tide Water's Edeleanu Process is done before your eyes and in the presence of a representative of the Electrical Testing Laboratories. In the above photograph, the Electrical Testing Laboratories' representative is checking the weight of the unstable extract.**

in his favorite oil

...NOW *convinced of Tycol's outstanding lubrication value*

RE-*refining of competitive oil by Tide Water's Edeleanu Process furnished convincing proof.*

This power plant operator was frankly skeptical, as others have been, when we offered to prove before his eyes that Tycol Diesel and Turbine Oils excelled all others. "Furnish us a sample of the oil you are using," we said, "and we will RE-*refine* it by Tide Water's Edeleanu Process. We'll take out impurities that conventional refining cannot remove."

Results of RE-*refining*

His favorite oil was rated as one of the best. Yet Tide Water's Edeleanu Process removed 13.3% of unstable extract, a sludging component with a gravity similar to that of low grade fuel oil, with 12 times as much carbon residue as the original oil, and a much higher oxidation number.

Of particular significance are the improved characteristics of the RE-*refined,* purified oil. Gravity was increased. The temperature-viscosity curve was flatter and the oxidation number was halved (see table). These improvements furnish convincing proof that oils refined by Tide Water's Edeleanu Process are superior to those produced by conventional refining methods.

That this should be is easy to understand. First of all, this exclusive process is a physical one—that of solution. All unstable hydrocarbons are dissolved and removed. There is no chemical action involved, which in other methods of refining impairs the desirable hydrocarbons while only partially removing the undesirables.

RE-refining of competitive oils is witnessed and the results certified by the Electrical Testing Laboratories, New York City.

100% Paraffine Base

Second, Tycol Turbine and Diesel Oils are 100% paraffine base. Small wonder, therefore, that being refined as they are, these oils have so many superior lubricating qualities.

What the laboratory indicates has been proved by convincing records of service in some of the country's leading power plants. Low acidity, low carbon deposition and better demulsibility—these are the qualities of Tycol Oils which give more economical lubrication.

You will be interested in the complete description of Tide Water's Edeleanu Process included in our Laboratory Report, "RE-*refining* 12 Brands of Oil." A copy is yours for the asking.

TIDE WATER OIL SALES CORPORATION
17 Battery Place, New York, N. Y.

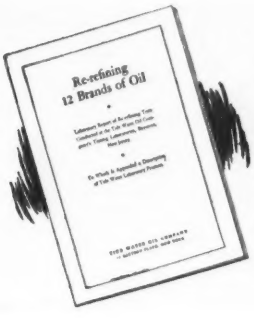
INDUSTRIAL TYCOL OILS-GREASES

TIDE WATER

Industrial Lubricants and fuels manufactured by

TIDE WATER OIL SALES CORPORATION

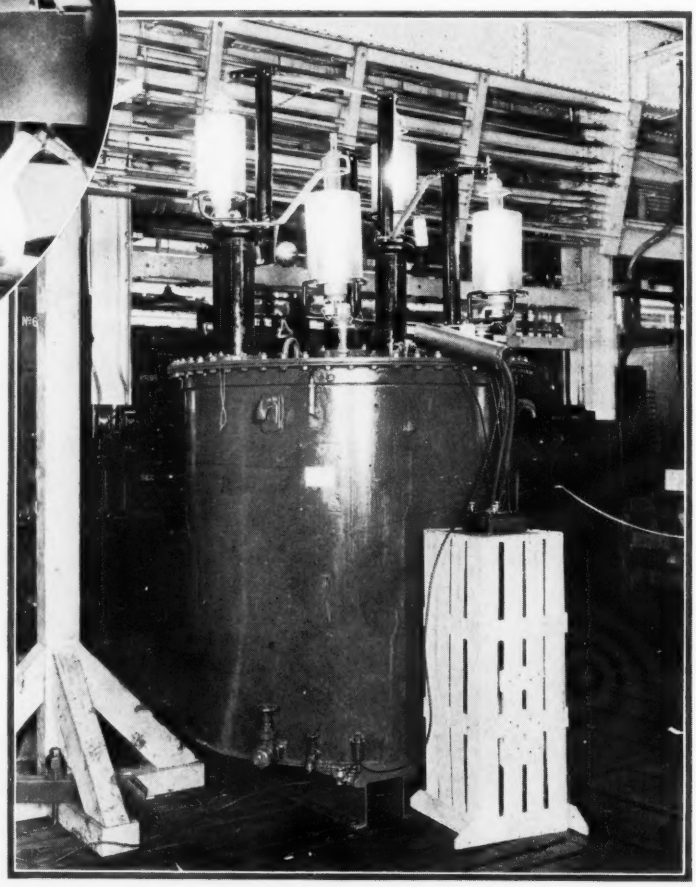
Compressor Oils	Hydraulic Turbine Oils
Cutting Oils	Steam Cylinder Oils
Textile Oils	Ball and Roller Bearing Greases
Transformer Oils	High Pressure Greases
Gear Greases	Roll Neck Greases
Fuel Oils	



"RE-*refining* 12 Brands of Oil" is a Laboratory Report of practical importance to users of Turbine and Diesel Oils. Send for a copy.

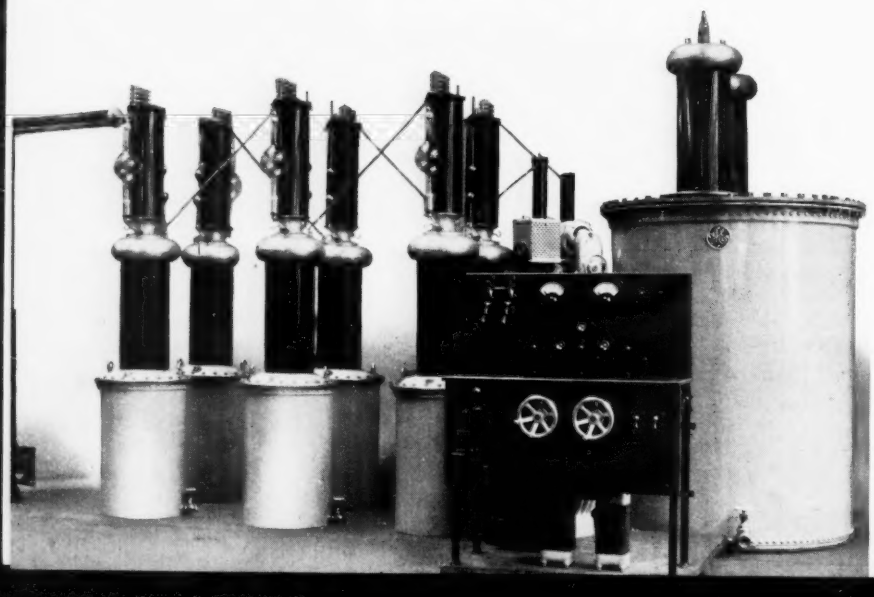
A.C. to D.C. via ELECTRONIC

● LEON R. LUDWIG is watching operations in an Ignitron mercury tube in which a tiny current applied to a pencil lead can control currents in an electric arc a million times greater



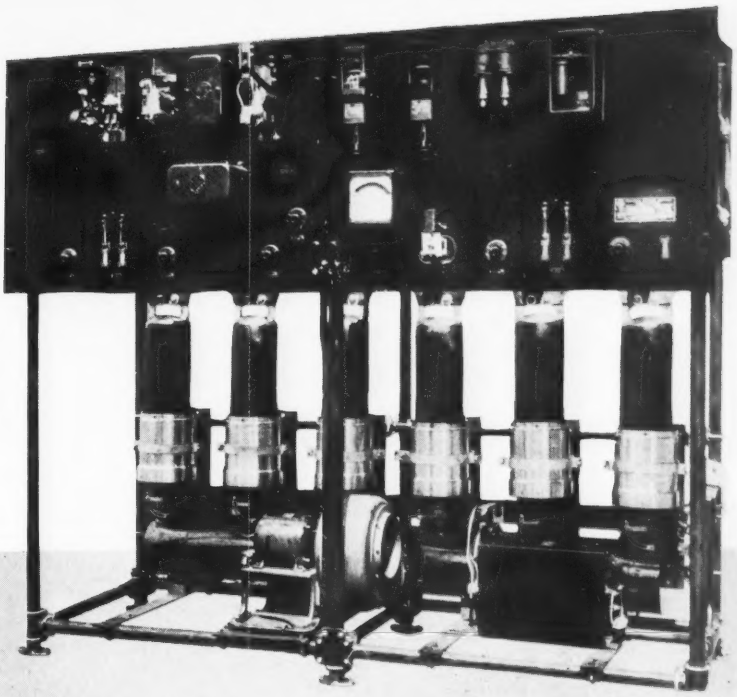
● HOT-CATHODE THYRATRON RECTIFIER has a rating of 600 amperes maximum and 100 amperes average at a maximum of 1,500 volts

● HIGH-VOLTAGE TRANSFORMER with rectifying tubes on its terminal for supplying direct current at 47,000 to 100,000 volts for electrically precipitating solid matter from flue gases of power plants and industrial processes

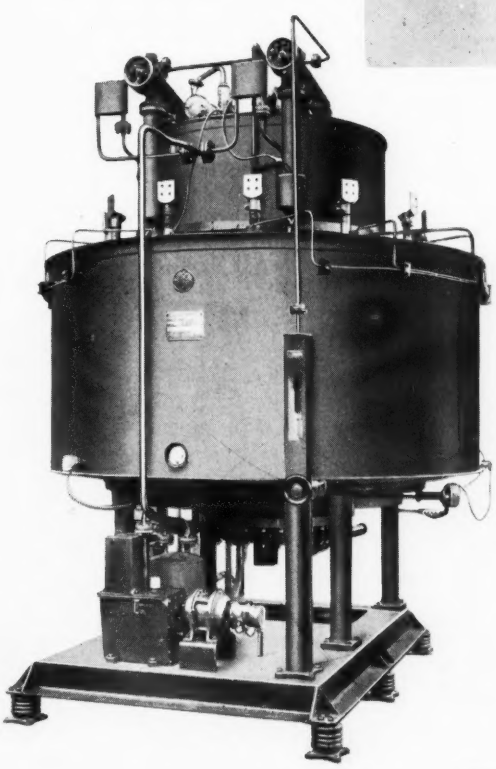


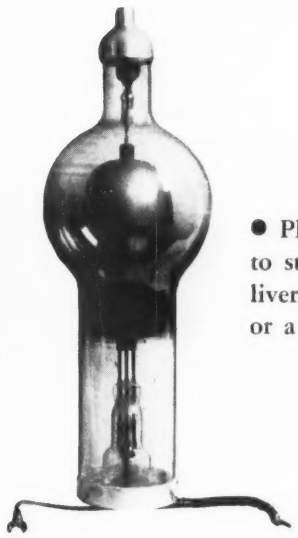
● A 250,000-VOLT, 250-milliampere, end-grounded direct-current cable-testing set. On the left are the six rectifying tubes mounted on the terminals of filament transformers, which also serve as insulating transformers

TUBES



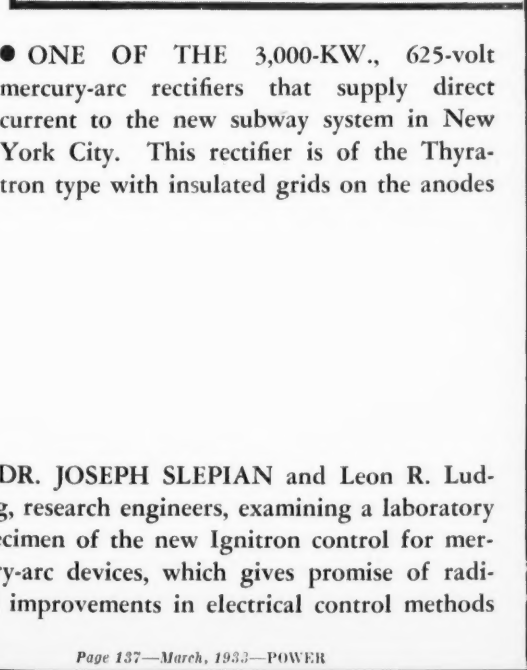
● PHANOTRON-TUBE type rectifier installed by the Boston Edison Company takes power at 13,800 volts three phase and supplies up to 600 amperes to a three-wire direct-current system



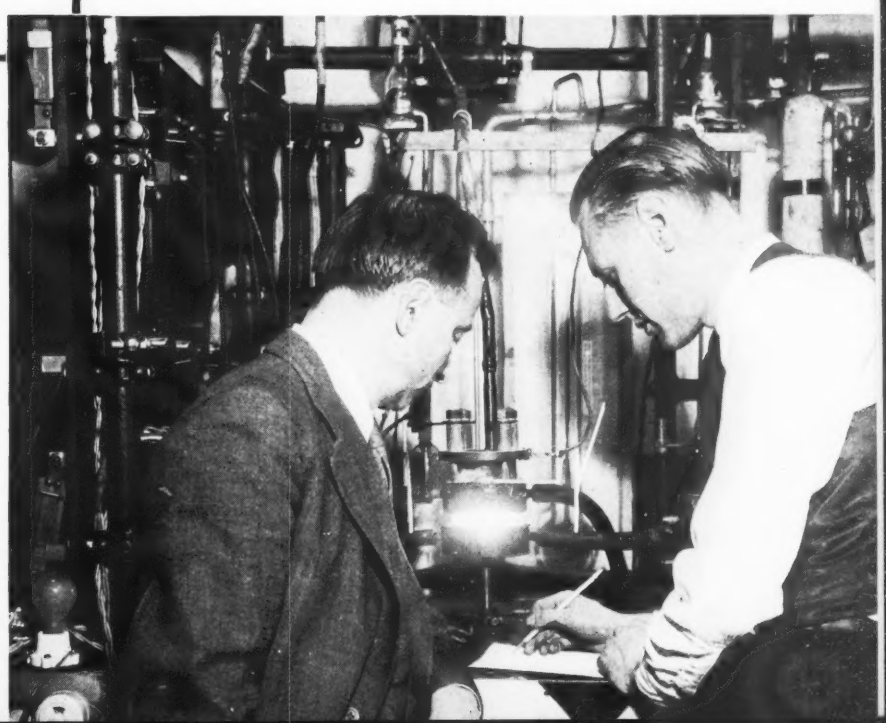


● PHANOTRON RECTIFIER rated to stand 20,000 peak volts and to deliver a maximum current of 40 amperes, or a continuous current of 10 amperes

Photos by courtesy of the General Electric Company and the Westinghouse Electric and Manufacturing Company

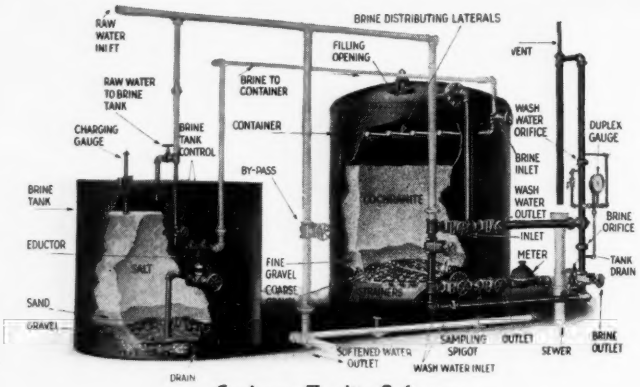


● ONE OF THE 3,000-KW., 625-volt mercury-arc rectifiers that supply direct current to the new subway system in New York City. This rectifier is of the Thyratron type with insulated grids on the anodes



● DR. JOSEPH SLEPIAN and Leon R. Ludwig, research engineers, examining a laboratory specimen of the new Ignitron control for mercury-arc devices, which gives promise of radical improvements in electrical control methods

COCHRANE SOFTENERS—FILTERS AND



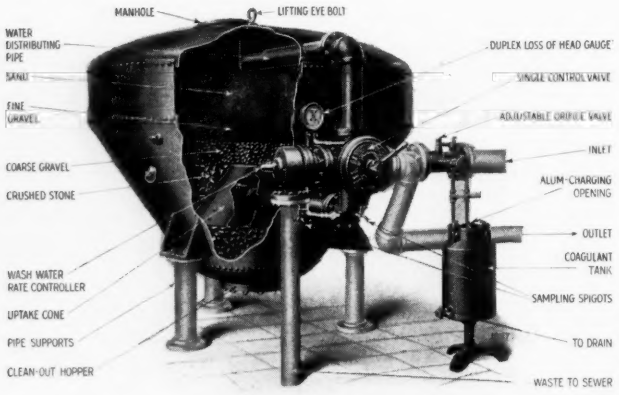
Cochrane Zeolite Softener

Zeolite Softener

For plant and water conditions to which it is suited

Where analysis of the water supply and of plant operating conditions indicates that a zeolite softener will give the most satisfactory and economical results, we recommend the type of equipment and of zeolite material which our experience has shown to be most suitable. Where the nature of the water is such that pre- or after-treatment is desirable, we supply automatic acid or lime feeders or deaerators of suitable and tested design. Cochrane Zeolite Softeners give unsurpassed service in textile establishments, hotels, hospitals, heating plants, central stations, state institutions, schools, laundries, dyeing and cleaning establishments, homes, etc.

Ask for Bulletin L-695



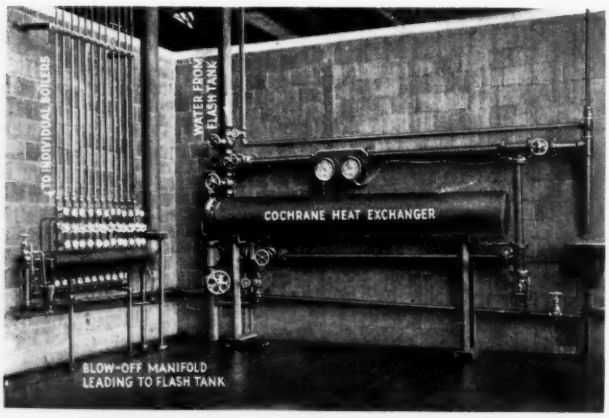
Cochrane Conical Filter

Conical Filters

For all water clarification service, particularly purification of oily condensate

Uniform distribution of water in both filtering and back-washing is effected by suitable shaping of the container, thus eliminating strainer heads and collecting manifolds and the possibility of their becoming clogged by sand, lime deposits or fibrous substances. A clean-out opening at the bottom provides for quick dumping of the filtering medium, as required from time to time when filtering oily condensate, while a new charge can readily be shovelled in through the manhole at the top. A single control valve renders the operations of filtering, back-washing and filtering to waste semi-automatic and fool-proof. Automatic coagulant feeders and rate of flow controllers are supplied where required.

Ask for Bulletin L-687



Cochrane Continuous Blow-Off Equipment

Continuous Blow-Off

Combats priming and foaming

To prevent undesirably high concentration of solids in the boiler water, as required to insure proper steaming, it may be necessary to blow off 5 to 10 per cent, or even more, of the water fed to the boiler. The Cochrane Continuous Blow-Off System does this continuously and automatically and at the same time recovers most of the heat and much of the water blown off in the form of steam at an intermediate or low pressure suitable for use in processing or in feed water heating. The savings thus effected, as compared with intermittent manual blowing down, soon repay the investment in the continuous blow-off equipment, in addition to the improvements in boiler operation and in steam quality.

Ask for Bulletin L-692

COCHRANE CORP.....PHILADELPHIA, PA.

CONTINUOUS BLOW-OFF EQUIPMENT

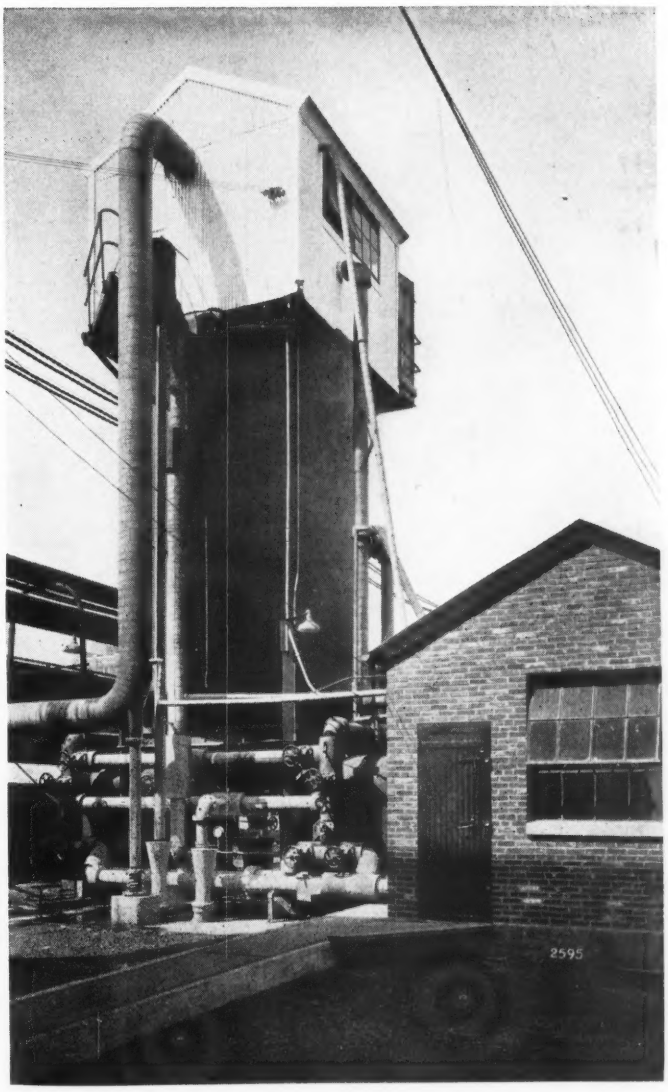
Hot Process Softeners

with 100% make-up

HIGH percentages of make-up in the boiler feed are often unavoidable where steam is consumed in processes or distributed to heating systems. At the same time many such plants are being equipped with high pressure, high rating boilers, making exact control of water conditions imperative.

COCHRANE HOT PROCESS SOFTENERS have met the requirements successfully in a wide variety of plants which use make-up in various percentages ranging all the way up to 100%. Supplementary phosphate treatment is provided where its need is indicated by high steam pressure or the nature of the raw water supply.

Boiler water conditions favorable to dry steam and protection of the boiler metal are further promoted by the Cochrane Continuous Blow-Down System, which holds concentration at the desired value with least waste of water and heat.

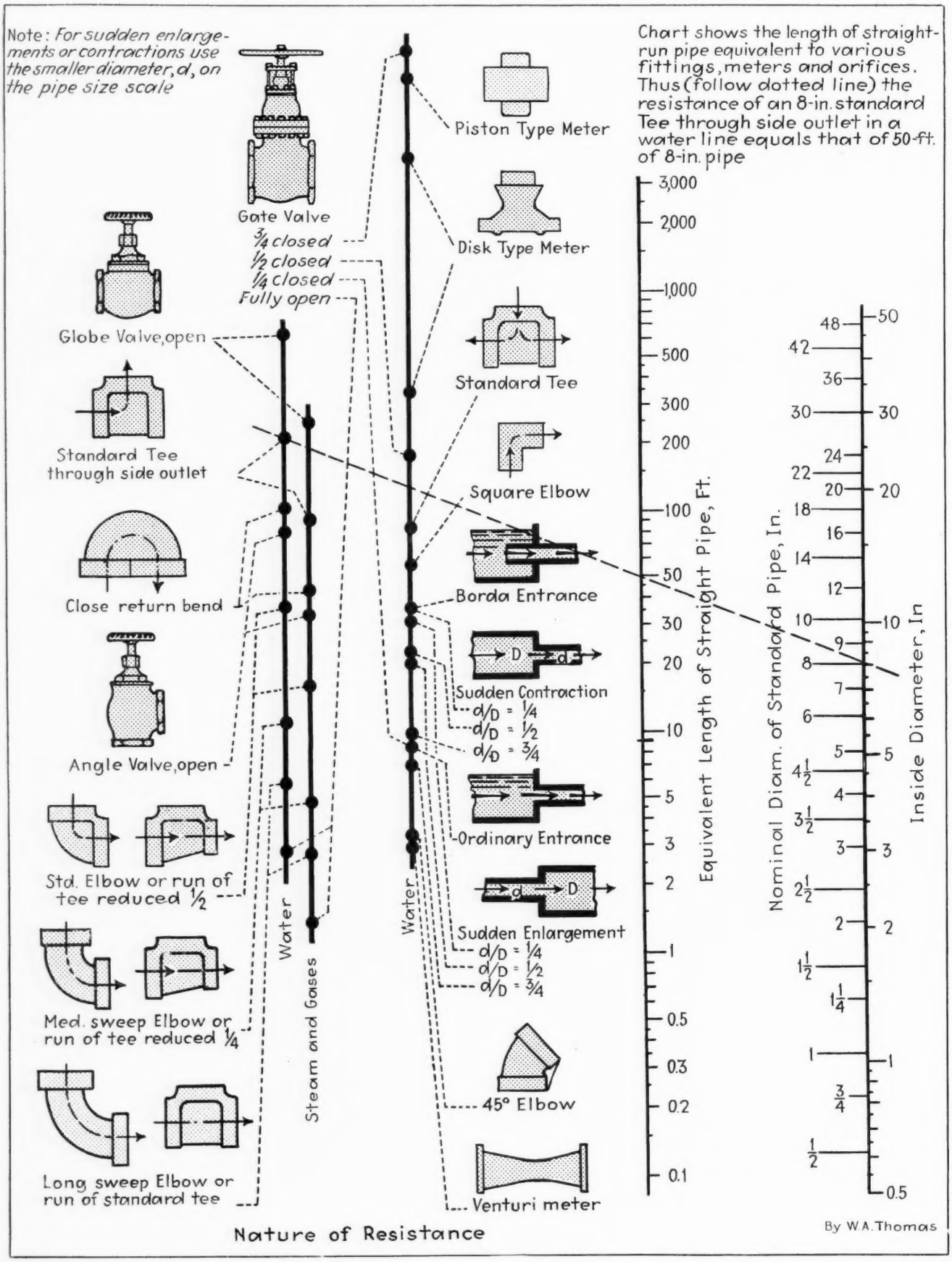


Cochrane Hot Process Softener Installation

F-16

COCHRANE CORP.....PHILADELPHIA, PA.

RESISTANCE OF FITTINGS



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BURLINGTON TURBINE

LARGEST 3,600-R.P.M. UNIT

By
E. ZETTERQUIST
Turbine Engineer, Westinghouse Electric & Manufacturing Co.

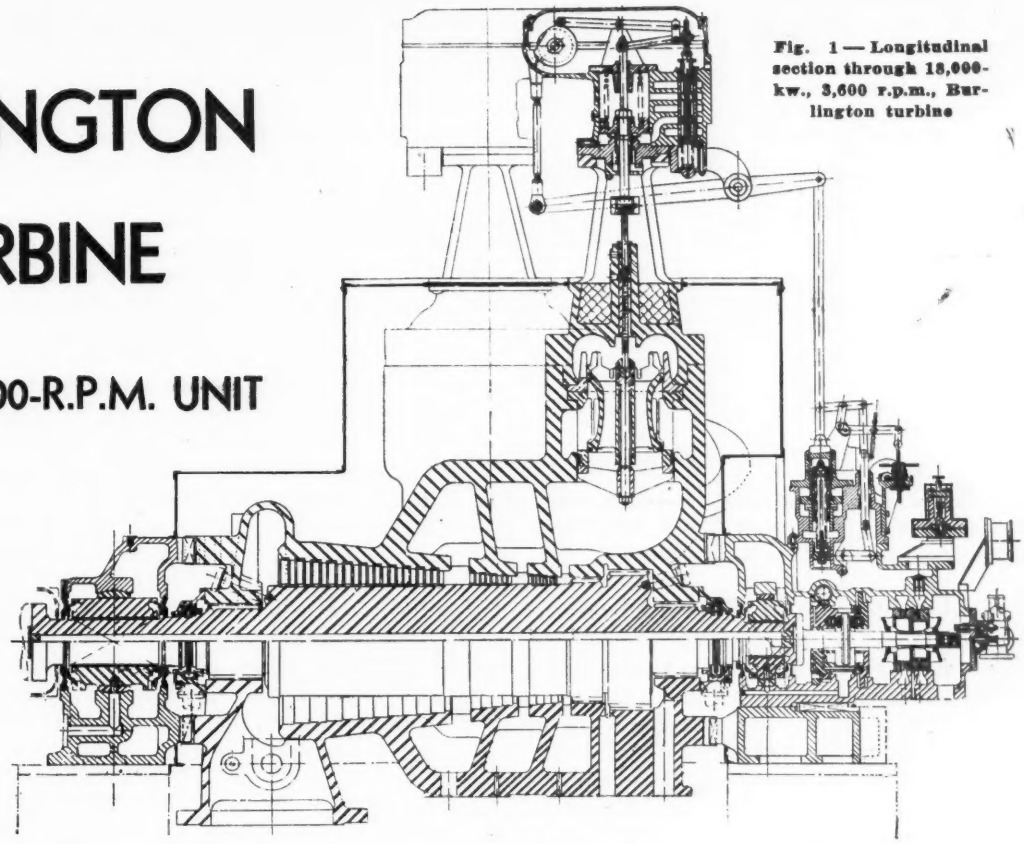


Fig. 1 — Longitudinal section through 18,000-kw., 3,600 r.p.m., Burlington turbine

Details of the 18,000-kw. high-speed turbine added to the Burlington station are here described. An article in the February number showed how this 650-lb. pressure unit operates with low-pressure turbines in the older part of the station

THE 18,000-kw. turbine placed in operation last year in Burlington (N. J.) station of the Public Service Electric & Gas Co. is an outstanding unit not only because it operates at 650 lb. pressure and 850 deg. but also because it is the largest 3,600-r.p.m. unit.

It is of the straight reaction type with three governor-controlled inlet valves for carrying total station loads of 26,800 kw., 40,750 kw. and 56,200 kw. Blading is arranged on a constant drum diameter and is of the axial clearance type. Shrouds are of 5 per cent nickel steel and cold riveted directly to the blade tenons. Single tenons are used for the narrower blade sections and double tenons for the wider sections.

To obtain equal running clearances throughout the machine, the blade shrouds and sealing strips, shown in Fig. 2, are "ground in" under normal load and temperature conditions. Grinding is done by moving the spindle toward the thrust end by means of a handwheel on the thrust bearing cage, until touch is obtained. The spindle is then immediately backed off to allow the blade shrouds and sealing strips to cool. The process is repeated until micrometer readings show a sufficient amount of material ground off to insure that all strips have been in contact. Location of the spindle relative to the cylinder is then adjusted by means of liners between the thrust-bearing pedestal and cage so that a minimum operating clearance is obtained with the spindle thrown toward the thrust end (running position), and a maximum clearance approximately 0.030 in. greater when thrown toward the coupling end (start-and-stop position).

Before starting up the spindle is thrown hard up into the start-and-stop position and maintained there until the machine is thoroughly heated and under load, after which it is backed off into the running position. Similarly, when the unit is taken off the line, the spindle is again moved into the start-and-stop position to insure maximum safety of operation.

Thrust on the spindle is sufficiently high at the higher load points to make it impossible to move the spindle by the force exerted on the thrust-bearing cage handwheel alone. To overcome this condition an oil balancing piston was introduced on the thrust-bearing cage. By admitting high-pressure oil on the forward side of the piston, a complete balance of the cage is obtained and the operator has but to overcome the frictional forces with the handwheel.

As a further precaution against rubs, the balancing dummies are proportioned to give a definite steam thrust toward the governor end under all conditions of load. In case of loss of load, when the steam thrust becomes zero, any pull on the spindle toward the coupling end, be it magnetic pull by the field or force of gravity, will tend to increase the running clearances by the amount of play in the thrust bearing minus the thickness of the oil film.

Fig. 2 illustrates the self-relieving feature of the balancing-dummy seals. In case of a rub the outer portions of the lands tend to increase in diameter from the heat generated and immediately cause a deflection of the lands away from the rubbing surfaces.

Since running clearances between the blades is in an

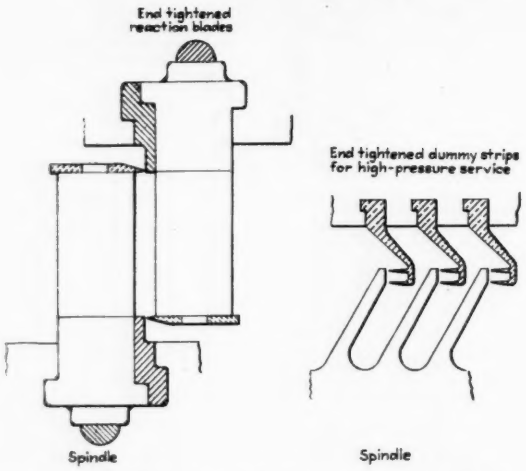


Fig. 2—Uniform axial clearance is obtained by grinding in under load, and dummies are provided with self-relieving seals

axial direction, it is of extreme importance that deflection of the blade ring diaphragms shall not occur when the turbine is under load and that temperature distortions be held to a minimum. To this end the blade rings and the high-pressure dummy barrel are tied together in an axial direction by heavy lugs cast integral with the casings, giving in effect a continuous cylinder around the steam path.

The spindle, except for the thrust shaft extension, is made from a single-piece carbon-steel forging with a central inspection hole bored throughout its length. The gland runners are made in halves and wedged in place over a *T*-type disk cut directly in the spindle forging.

Cylinder halves are bolted together by heavy stainless steel studs, located alternately in the cylinder base and cover. To insure uniform pressure on the joints, the studs are heated by hot air circulated through holes drilled centrally in the studs until sufficient expansion is obtained to produce a definite stress after the nuts have been drawn up and the studs allowed to cool. The central portion of the joint directly under the studs is relieved so that the pressure from the bolting is concentrated along the cylinder walls only. To relieve thermal stresses in the cylinder flanges, transverse slits, alternating in the upper and lower halves, are cut through the flanges between their outer edges and the clearance holes for the studs.

The governor, shown in detail in Fig. 3, depends for its operation upon the variation in oil pressure produced by changes in speed of the impeller on the turbine shaft and consists essentially of an inner, spring-loaded relay-type sleeve and an outer operating piston. High-pressure oil from the governor impeller enters the lower half of the governor housing through a check valve and acts upward on the relay sleeve and also on the annular ring at the bottom of the operating piston. This pressure on the operating piston is continually trying to close the governor valves. The upward force on the relay sleeve is balanced by the tension spring, the lower end of which connects to the operating piston stem through a system of levers and in this manner gives a further closing force to the governor.

The relay sleeve controls the admission or discharge of oil to or from the upper side of the operating piston only, this oil being drawn from the impeller discharge through drilled holes in the relay sleeve and discharged between the sleeve relay and operating piston to the lower side of the piston, which connects to the impeller suction. With an increase in load and decrease in speed, the pressure drops slightly, causing the sleeve to drop a small amount and open up the ports to increase the oil pressure above the operating piston. This results in a downward movement of the piston, which movement is transmitted through the camshaft to the individual relay of the governing valve, causing the relay to drop slightly to admit high-pressure oil to the lower side of the valve operating piston and open the valve an amount sufficient to carry the increased load.

A trip mechanism, shown to the left in Fig. 3, affords protection against loss of oil on the bearings or impeller supply. The piston on the lower side is held up against the compression spring by the bearing supply oil pressure existing beneath the piston. If this pressure drops below approximately $2\frac{3}{4}$ lb. per sq.in., the spring will drop this piston and the plunger connected to it. The upper end of the governor-operating cylinder will then be open to the bearing and impeller supply. This means that whatever oil is pumped by the impeller will go to the bearings and also that the governor will close the steam inlet valves. The trip requires an increase in bearing oil pressure to slightly over 5 lb. before reseating.

The second impeller, adjacent to the oil governor impeller, supplies oil to the bearing system and to the relay-

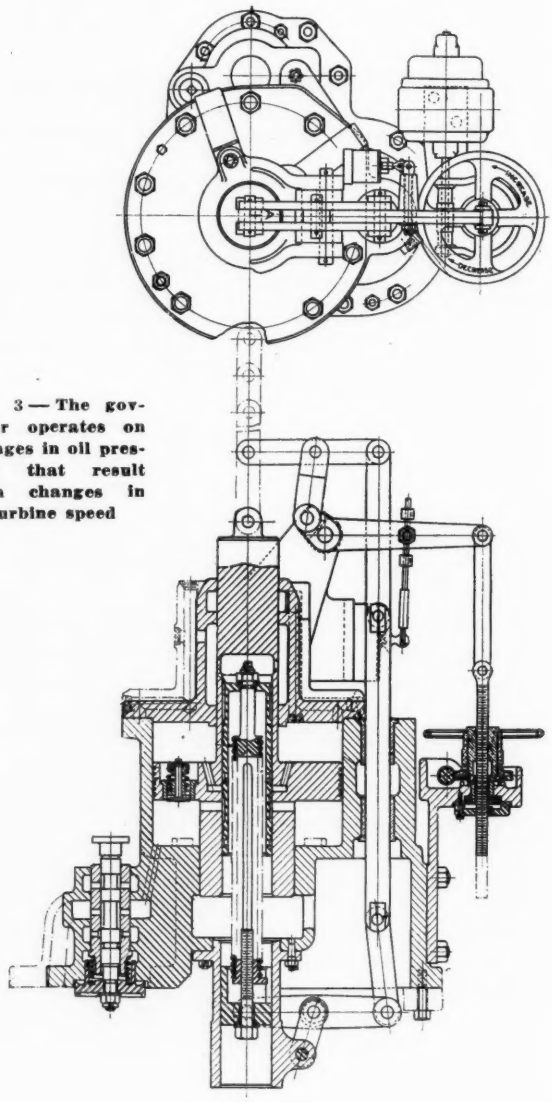


Fig. 3 — The governor operates on changes in oil pressure that result from changes in turbine speed

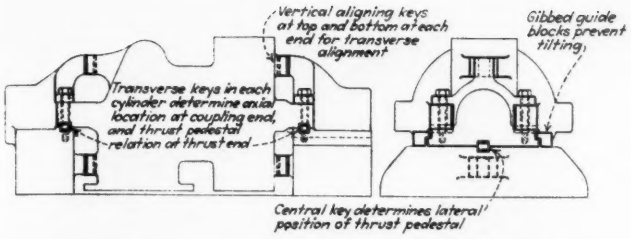

Vertical aligning keys at top and bottom at each end for transverse alignment
Gibbed guide blocks prevent tilting
Transverse keys in each cylinder determine axial location at coupling end, and thrust pedestal relation at thrust end
Central key determines lateral position of thrust pedestal

Fig. 4—Sketch showing how turbine is aligned

controlled operating pistons on the governor valves. By this arrangement the stability of the governor is not affected by surges in oil pressure from opening or closing of the steam admission valves.

A change in speed is effected by raising or lowering the speed-changer screw which controls the tension in the relay sleeve spring, either by hand or by means of the speed-changer motor.

The back-pressure regulator is connected to the upper side of the governor relay and normally maintains a constant oil pressure at this point. If the exhaust steam pressure reaches the predetermined maximum of 205 lb. per sq.in., the regulator reduces this oil pressure, allowing the sleeve to rise slightly. Reacting through the governor system, this causes a reduction in steam flow sufficient to keep the exhaust pressure just at the limit.

Alignment of the turbine is illustrated in Fig. 4. Two transverse keys between the turbine cylinder and the coupling bearing pedestal, which is bolted solidly to the foundation, serve as anchorage in an axial direction, yet allow free transverse expansion. Similar keys at the governor end tie the cylinder to the thrust-bearing pedestal, which slides on the sole plate and is prevented from transverse movement by a central key between the pedestal and the sole plate. Vertical keys at top and bottom at each end of the cylinder maintain transverse alignment but allow free vertical expansion.

The direct-connected generator is rated at 18,000 kw., 80 per cent power factor and delivers 60-cycle current at 13,200 volts. It is equipped with a 90-kw., 250-volt, shunt-wound, direct-connected exciter.

Deslagging Boiler Tubes with Water

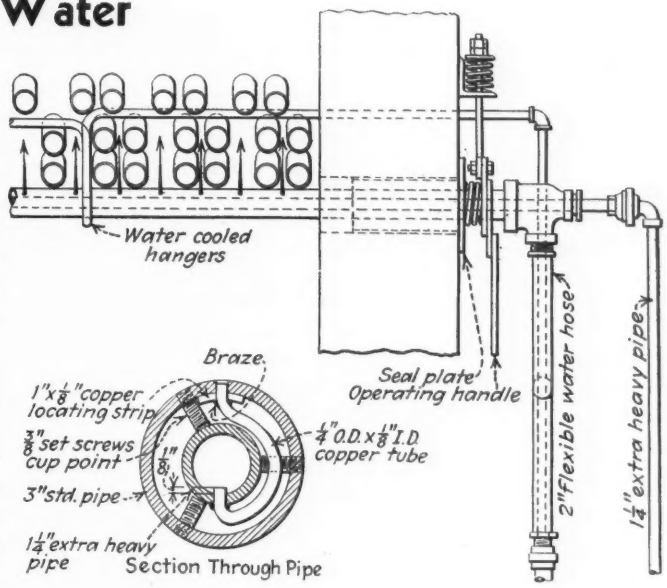
METHODS of removing slag from boiler tubes vary, depending upon type of boiler and general operating conditions. Usually, deslagging involves considerable manual labor and waste of fuel due to air infiltration during cleaning periods. In some plants the lower tubes are scraped during light-load periods with hooks inserted through special access doors just below the tube banks. This is sometimes supplemented by hand lancing using either steam or water for removal of accessible slag.

It is quite a task to maintain tubes free from slag with some fuels, and slag accumulation results in a reduction in boiler capacity. Some plants clean heating surfaces thoroughly with lances, scrapers and brushing whenever a boiler is idle for repair or inspection. This is necessary if full unit capacity is to be maintained. It also reduces maintenance by minimizing highly localized gas velocities which occur when a boiler is badly slagged.

A new device for slag removal has recently been installed on one of the stoker-fired, 250,000-lb. per hr. boilers at Hell Gate. The new method utilizes slugs of water at high pressure sprayed through an element into the passages in which slag tends to accumulate. It is so connected that by the operation of a valve, water and air may alternately be discharged through the element. The purpose of the air is to permit discharging the water in slugs, thus increasing the effective distance of slag removal.

The device, called a deslagger, is designed and manufactured by H. T. Weis. It consists of a smaller pipe inside a larger pipe. The inside pipe is supplied with feedwater under 400-lb. pressure. Water from the inside pipe is lead by flexible copper tubing to nozzles in the outer pipe through which the water jets onto the boiler tubes. The annular space between the two tubes is cooled with city water.

The deslagger extends across the 20-ft. width of the furnace and is supported underneath and at right angles to the bottom row of boiler tubes a short distance in front of the rear tube headers. As shown by *B*, it is hung



from the boiler tubes by a water-cooled pipe that alternately loops under the deslagger and over the second row of tubes. Water for cooling flows in series, first through the annular space in the deslagger and then through the hanger.

Cooling water is supplied through a flexible hose and the high-pressure water through a swivel joint so that the deslagger element can be rotated through an arc of about 45 deg.

The unit is used once a day and appears more effective than the usual manual method. It can be used without banking the boiler or decreasing the rating. No detrimental effect of the water impinging on boiler tubes is discernible, and boiler settings are not affected.

When first installed it was found that considerable heat was lost in the cooling water, enough to make it appear economical to install heat recovery equipment. After continued use, however, it was discovered that slag collected on the element in such quantity that the heat transfer and heat loss to the cooling water become almost negligible.

By R. B. SMITH
Turbine Apparatus Division,
Westinghouse Electric & Manufacturing Co.

INSTRUMENTS

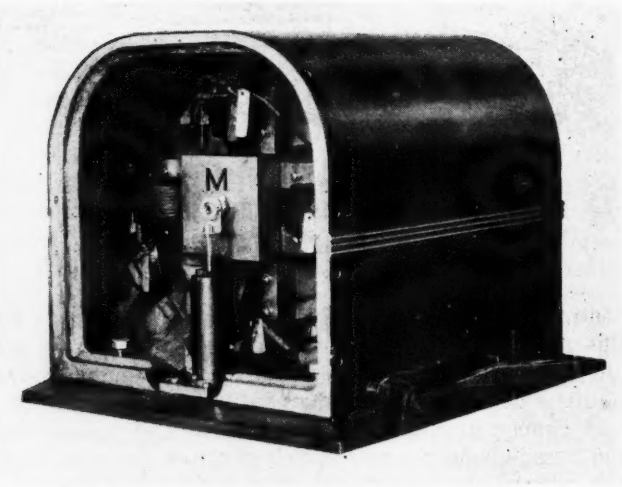


Fig. 2—Electrical vibrometer records turbine vibration

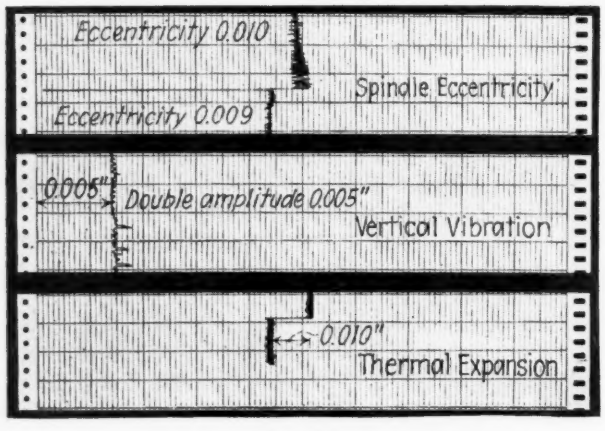
SUPERVISE CONTROL OF

APPLICATION of supervisory control instruments to steam-turbine generators affords a means of increasing power-station operating efficiency and reliability. Instruments to indicate speed, bearing temperature, valve positions and similar factors have been in successful operation for some time. Only recently, however, have instruments been available to remotely indicate and record the characteristics of turbine performance, such as vibration, spindle eccentricity and axial position, thermal expansion of the casing, as well as detectors to give warning of blade and gland rubs.

The installation of these instruments with suitable warning alarms will place the mechanical operation of power-generating equipment on an automatic basis. In addition, the analysis of graphical records by the plant engineer will result in a more rational method of approaching the problem of efficient steam operation.

One of the most valuable of these instruments is the electrical vibrometer, Fig. 2. The central mass *M* is seismically supported and remains unaffected by high frequency impulses in the vertical or the horizontal plane. Small transformers on either side of the stationary armature, separated from it by air gaps, partake of the motion of the instrument. This motion alters the magnetic characteristics of the former circuits. When the primaries of two transformers on the same center line are in series and their secondaries are connected in opposition, as in Fig. 5, there is a differential voltage across their common terminals. This voltage is a direct function of the relative motion of the transformer coils in respect to the armature. The application of high-frequency electrical energy results in a sensitive and compact vibrometer.

Fig. 1—Record of instruments for measuring spindle eccentricity, vibration and thermal expansion



The alternating potential produced by the vibratory motion is rectified by copper-oxide disks *R* and is measured by potentiometer-type indicating and recording instruments. The application of potentiometer recorders is advantageous, since the record is independent of ambient conditions and the distance from the source of the impulses. Thus turbine characteristics may be observed at any convenient centralized point quite apart from the measuring source.

The vibrometer has a linear calibration in either the horizontal or vertical direction with an amplitude range of 15 mils. Horizontal and vertical records may be made simultaneously. Since the instrument is simple and compact it may be applied to any type of machinery in which a remote indication of vibration would be desirable.

Of equal importance to turbine operators is spindle eccentricity. Although the phenomenon of temperature distortion is appreciated and every effort is made to start the machine carefully, turbine accidents that result from this cause emphasize the necessity for automatically measuring spindle eccentricity. With the trend toward reduced clearance in order to meet higher efficiencies, spindle truth becomes even more important.

The eccentricity recorder, Fig. 3, employs no mechanical contact with the rotating element. On either side of the shaft are small transformers, the electrical connections for which are identical with those in Fig. 5 With the spindle aligned and the shaft ground to truth, the air gaps of the two transformers are adjusted equally, resulting in a zero differential voltage across the secondaries. As the shaft revolves any displacement of the geometric axis produces a periodic variation of the two air gaps. This differential secondary voltage, the result of the motion, is given on the recording or the

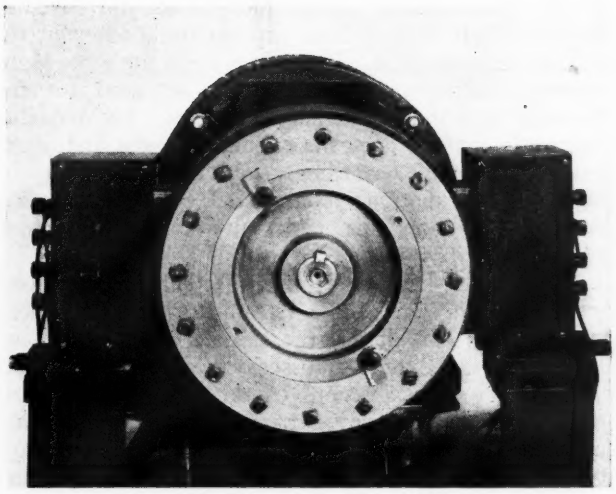


Fig. 3—Turbine-shaft eccentricity recorder

Instruments record turbine vibration, spindle eccentricity and axial position, thermal expansion of the casing and warn of blade or gland rubs, thus making turbine conditions immediately apparent to the operating engineers

STEAM TURBINES

indicating instrument. Like that of the vibrometer, the scale is linear and the range may be adjusted to suit the installation.

The instruments are supported from the bearing pedestal and have been designed to fit into the space between the gland casing and the pedestal without an increase in the axial length of the machine. Suitable provision has been made to allow for thermal expansion without affecting the instrument's calibration. Excessive moisture and temperature will not influence the electrical circuit. Inasmuch as there are no moving parts the sensitivity is not affected by friction or wear.

Fig. 1 shows graphical records from the various instruments. The open scale and the rapidly moving recorder pen facilitate accurate and responsive measurements.

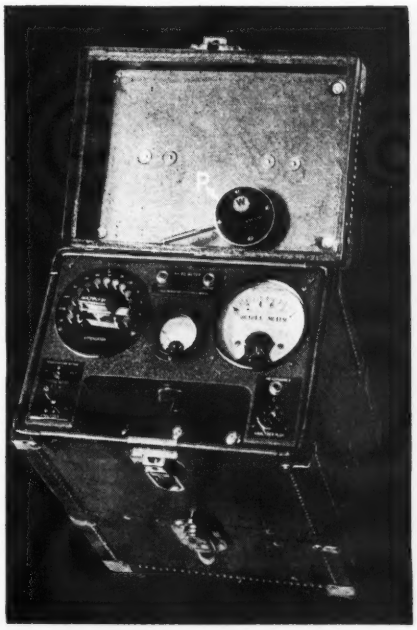


Fig. 4—Instrument for detecting blade or gland rubs

Since the majority of turbine accidents are the result of blade or gland rubs at points of reduced clearance, it is desirable to detect a rub at its inception so that corrective measures may be taken promptly. The instrument in Fig. 4 consists of a very sensitive detector that will respond to unusual sounds within the machine and give warning of changed conditions. At present, turbine rubs are detected with a listening rod through which the sound waves travel to the ear drum. Naturally the measurement is closely allied with the human factor as well as the adjoining noise level. The electrical ear responds mechanically to the vibrations transmitted through the casing, and records them on suitable instruments irrespective of the surrounding conditions.

The magnetic pickup, *P*, Fig. 4, is the sensitive element. It consists of a high-strength permanent magnet flexibly mounted within the case. A coil situated between the poles of the magnet generates an electromotive force when it is moved across the flux lines by the vibrations created by the sound. When the stylus of the instrument is held against the turbine casing the coil moves in response to the sound radiated from the casing. In principle the pickup does not differ from the listening rod, but by the application of the amplifier and measuring circuits, a quantitative estimate of the sound is secured. Head phones connected to the output give an audible measure of the magnitude of the sound, and allow a check on the indicator readings.

Numerous factory tests, as well as field investigations, have demonstrated the sensitivity of the instrument. It has been found that a gland rub can be detected whether the pickup be located immediate to the source of the waves or several feet away. The fact that the amplitude is under control when the head-phone circuit is used makes the measurement many times more sensitive than the listening rod.

In applying this instrument to steam turbines, there will be several pickups mounted at important points on the machine, for instance on the gland casings, and on the turbine casing near points of reduced clearances. Their circuits will lead to a common amplifier and to a recorder. Any variation in the continuous graphical record will give warning of an unusual condition that may be verified by switching on the telephone set.

Since the nature of sound is vibration at high frequencies (the audible range depends on the individual but generally runs from 50 cycles per second to about 20,000), the magnetic pickup functions as a sensitive vibrometer. In fact, it can be made to measure ordinary

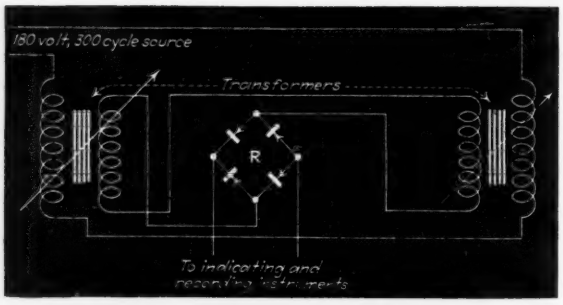


Fig. 5—Diagram of connections for electrical vibrometer, Fig. 2

machinery vibration with only slight readjustment. In this case the electrical circuit is built to respond to large amplitudes and the compliance of the spring arranged to suit the frequencies of the impulses that act on the casing. In this manner a sensitive and extremely compact vibrometer results that has a wide field of industrial application.

In order to measure larger movements, for instance those that result from thermal expansions, another instrument has been designed. It operates from the same high-frequency, 0.25-kw. motor-generator set used for the vibrometer and the eccentricity recorder. The movable armature is controlled by the expanding mass and alters the magnetic circuit accordingly. Its calibration may be made to include motions as large as 0.75 in. with measurements less than one per cent of the maximum movement.

In the past, it has been found that restrained expansions of certain parts of a steam turbine introduces internal forces that distort the spindle or the casing or both to such an extent that serious vibratory troubles develop. A graphical record of the motion will afford a ready means of detecting troubles arising from this phenomenon. Then too, on machines in which there are close axial clearances a shaft axial-movement detector may be embedded in the thrust bearing housing and actuated from the shaft in such a manner that the axial spindle setting will be recorded under all conditions.

IDLE LEATHER-BELT DRIVES
Need Inspection and Maintenance

DURING the past two years many plant operators have "robbed Peter to pay Paul" in order to keep machines running at a minimum of expense, according to a statement just released by J. N. Smith, Engineering Department, E. F. Houghton & Company. Belts have been taken off equipment which was temporarily shut down and used on other drives where they were needed. This practice is quite common and cannot be condemned, but, on the other hand belts should be given more consideration.

Many plants undoubtedly have belts that have stood idle for some time. Before this belting is put back into service it should be carefully inspected and reconditioned if necessary. Belting often deteriorates more rapidly when idle than when in regular use. In addition, many things can happen to an idle belt, and invariably the belt will need some attention to place it in first-class condition. When inspecting the belts, attention should be given to the following:

1. Is the belt saturated with oil or covered with dirt?
2. Are there any open laps?
3. Is its length correct?
4. Are fasteners worn or broken?
5. Are the pulleys in proper alignment?

If belts have become soaked with mineral oil, degrease them by soaking in gasoline or carbon tetrachloride for 24 hr., or longer if necessary. Degreasing not only removes all mineral oil but also the natural oil which is essential to lubricate the fibers of the leather. Therefore, after the belt has been degreased, dress it with a good belt lubricant to lubricate and preserve the fibers of the leather.

Do not use a sticky belt dressing, as it will not lubricate the leather. Never permit foreign matter, such as lumps of belt dressing, dirt, wood chips or adhesive material of any kind, to gather on the belting or pulley faces. Clean the belt off by scraping it with a dull-edged scraper with rounded corners. Do not use a sharp scraper, for the fibers of a belt must not be injured.

Check all the laps and see that they have not started to separate, especially the tip of the lap. If it is found necessary to re-cement a lap, be sure to scrape off all of the old cement. The laps should then be thoroughly roughened, either with coarse emery cloth, a rasp or wire brush before the cement is applied.

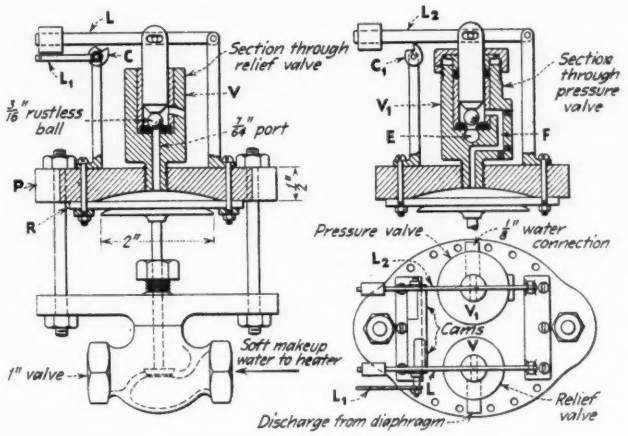
A belt which has been left on an idle drive under tension has no doubt become permanently stretched. Therefore it is wise to remove the belt from the drive and shorten it to the proper length to give the desired tension on the drive. If the drive is to be idle for some time, do not install the belt on the drive tight. It is better not to install the belt at all until it is needed.

Fasteners of all types should be gone over carefully. If any of them are worn or broken they should be replaced immediately. A worn fastener is liable to let go at any time. A broken fastener will not only cause the belt to run crooked but will also damage wood or composition pulleys.

Pulley alignment is very important from the standpoint of belt life and transmission efficiency as well as the operator's safety and should be carefully checked during inspection.

The application, maintenance and repair of belting should be in the hands of a competent man trained in this service. Many good belts have been ruined by improper repairs. If the plant does not have the facilities for properly reconditioning belting, any reliable belt manufacturer can provide men to do this work. The belts will then receive the best care that good workmanship can produce.

PRACTICAL AIDS TO OPERATION



Automatic Control Valve for Makeup Boiler Feedwater

THE automatic valve that I made to control the make-up water to a feedwater heater may prove of interest. It was made from material picked up around the plant and has served the purpose satisfactorily. A diaphragm plate P for the control is made from a piece of $\frac{1}{2}$-in. steel plate, hollowed on one side to permit free circulation of the pressure water for controlling the makeup-water valve.

On the under side of the diaphragm plate a rubber diaphragm R is attached. It rests on a disk on the top end of the makeup-water valve stem. When makeup water is not required, pressure water from the city main is admitted above the diaphragm to hold the makeup-water valve closed. When the returns to the feedwater heater are insufficient, pressure is released from above the diaphragm, and the pressure of the makeup water under the valve opens it and water flows to the heater.

The control of the makeup-water valve consists of two ball-type valves. Functioning of these valves is regulated by the height of the water in the feedwater heater by a float. One of the valves relieves the pressure on the diaphragm and is shown in section at V. The ball is held on its seat by a weighted lever L and is allowed to raise off its seat by the cam C lifting lever L. Cam C is rotated by the movement of the float in the feedwater heater connected to lever L_1. The other valve, shown in section at V_1, controls the pressure on the diaphragm through a ball valve, the valve being held to its seat by the weighted lever L_2. This lever is also lifted by a cam C_1 controlled by the same float as the cam C. In fact, the two cams are on the same shaft as shown by the diagram in the lower right-hand corner of the illustration. Pressure water is admitted under the ball valve through connection E, from the city main. When the weight of the lever is lifted off the ball water flow through port F into the diaphragm chamber to hold the makeup-water valve closed.

The positions of the cams C and C_1 in the figure are those when the returns are sufficient to maintain the water level in the heater at a correct level. Under this condition, weighted lever L rests on its ball valve and holds the discharge port from the diaphragm chamber closed. Cam C_1 has lifted weighted lever L_2 and pressure water from the city main passes up through the ball valve and into the diaphragm chamber and deflects the rubber diaphragm downward to hold the makeup valve closed.

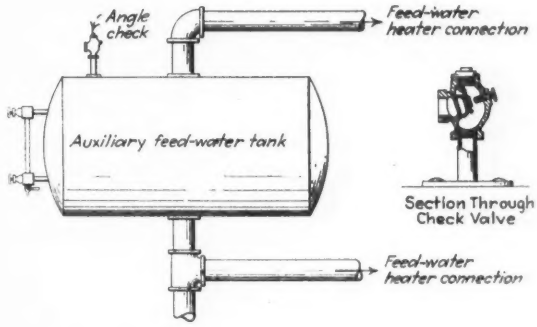
Low water in the feedwater heater allows the float to take a position where it will turn the cams to a position to lift lever L off its ball valve and put the weight of lever L_2 on its ball valve. This operation cuts pressure water off from the diaphragm and releases the pressure on the diaphragm through valve V, which allows the pressure of the makeup water under the valve to open it and restore the water level in the feedwater heater, at which time the control is returned to the position shown in the figures and the makeup valve is closed. It should be understood that the cams are so arranged that pressure control valve V_1 closes slightly before the relief valve V opens and V closes before V_1 opens.

The valve disk does not lift more than $\frac{1}{8}$ in. and is easily taken care of by the rubber diaphragm. Round iron forms the body of the ball-valve unit which has brass plungers and liners. A piece of Monel metal was used for the ball seats. Supports for the cams and the weight arm fulcrums were made of $\frac{1}{8}$-in. steel.

Edmonton, Alta. F. POLLOCK.

Check Valve Used As a Vacuum Breaker

IT IS frequently necessary to provide some sort of a vacuum breaker on a closed tank used for the storage of water, for example, an auxiliary feed-water storage tank. A check valve, connected to a threaded opening in

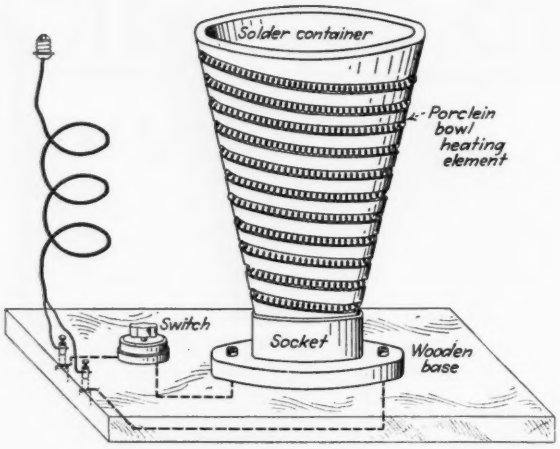


the top of the tank with a pipe nipple, and so placed as to open into the tank, as in the figure, serves the purpose effectively and at little expense. Either a vertical- or angle-type check should be used.

Arlington, Mass. THERON W. BEAN.

Easily Constructed Soldering Pot

A HANDY addition for an electrical repair kit is an easily constructed soldering pot for tinning wire ends and similar soldering work. A discarded sunbowl type electric room heater was available. The heating element consisted of a porcelain bowl, grooved in a spiral on its out-



side circumference, as in the figure. Resistance wire was wrapped in this groove in the usual manner.

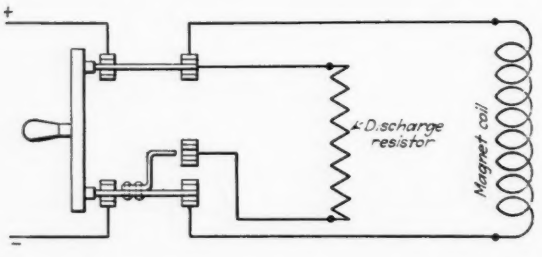
This heating element was screwed in a socket mounted on a wooden base. A snap switch was also mounted on the base, and a 10-ft. length of lamp cord was connected to the switch. A small quantity of fireclay was pressed into the cracks around the lower resistance terminal of the heating element and into the case to prevent any possible leakage of molten solder. This outfit, when filled with scraps of solder, would melt it in a short time and was easily carried in the tool box from one job to another.

Milford, N. J. HARRY M. SPRING.

Protecting Magnetic Circuits Against Induced Voltages

DIFFICULTY with induced voltage from magnet coils was recently experienced in a pulverized-coal station. Magnetic coils were provided in a conveyor pulley to remove tramp iron. A two-pole fused knife switch in a switch box was provided to control the circuit. This box was of the bullseye type with an electric light bulb serving as a pilot light to indicate when the circuit was alive. Trouble was experienced with frequent burning out of the lamp. Vibration was thought the cause, and no further attention was given.

After this plant had been in operation for some time the magnet coils in two of the pulverizers failed. It was



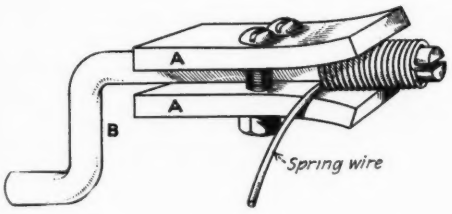
then decided that the same fault which had caused the lamp failures was the cause of the coil breakdowns. The pilot light was wired to the load side of the switch and it was found that the lamp burnouts occurred each time the circuit had been broken because of the high-voltage surge produced. Also the induced voltage was built up to a value that caused an insulation breakdown in the magnet coil.

A field-discharge switch was substituted for the standard knife switch. This switch was of the usual type having an auxiliary contact and blade, as in the figure, that connected a resistance across the magnetic circuit when the supply voltage was disconnected, to absorb the high induced voltage. No further trouble has occurred since this change.

Philadelphia, Pa. M. D. ROGERS.

A Handy Tool for Making Spiral Springs

BEING in need of some small spiral springs that were not available and having no tool at hand with which to make them, I constructed the device shown in the figure. It consists of a piece of $\frac{1}{8}$-in. round iron stock, *B* bent to form a crank at one end and slotted at the other. This is held between two pieces of $\frac{3}{32}$-in. fiber *A* by two bolts. To make a spring, the rod is clamped between the two pieces of fiber, with its end about flush with those of the fiber. The end of the spring wire is then placed in the slot and by turning the crank the wire



is forced around the rod to form the spring. As the wire is wound on the rod the turns of the spring force it out from between the fiber pieces as in the figure. This little device is easily made and can be held in the hand when making small springs. For larger springs it may be clamped in a vise. EDWARD B. BLACK.

Jeannette, Pa.

Metals Brazed With Silver Solders

SILVER solders is extensively employed for joining metal parts when greater strength is required than can be obtained by ordinary soldering or when the high temperature of welding methods may affect parts adjacent to those being joined. Brass, bronze, copper, nickel and Monel-metal power-plant equipment, can be repaired so effectively by brazing with silver solder that the brazed joint will be approximately as strong as the metal itself. Many power-plant engineers associate high cost with silver solders. However, because of their free flowing properties and the fact that joints require little finishing, these solders are economical to use.

Too much care cannot be taken in preparing the metal parts to be repaired or joined. Although a good flux will dissolve films of oxide during the brazing operation, it is essential to start with perfectly clean surfaces. Various methods of cleaning may be employed, such as filing, scraping or grinding. If the parts are greasy they should be immersed in a hot alkali solution to remove all trace of grease or oil. The parts should be held together firmly while the brazing operation is being performed. Silver solder is remarkably fluid when in a molten state and penetrates interstices which ordinary brazing spelter would fail to fill. Only a film of silver solder is neces-

sary to form a strong joint. It is wasteful to use the solder as a filling-in material.

In order to protect the metal surfaces against oxidation and to assist in the free flowing of the silver solder a flux is essential. Experience has shown that either calcined (fused) borax, or a mixture of borax and boric acid will give good results. However, the borax is generally more satisfactory when used in the following ways: (1) Dissolve borax in clean hot water to make a saturated solution. (2) Mix calcined borax with alcohol. This flux should be kept in a closed container to prevent evaporation when not in use. The saturated borax solution should be kept hot while using, as the borax is then more evenly deposited.

Great care should be taken not to overheat the metal parts with the torch flame during the brazing operation. When sufficient preheat has been applied to the joint, the flame should be moved away and the silver solder brought to the joint, where it will melt and flow quickly if the parts have been properly cleaned, fluxed and preheated. The heat should be continued only long enough to cause the solder to flow freely. Prolonged heating with the torch flame tends to oxidize and weaken the solder and the base metal. As soon as the brazed joint is completed, immerse the piece in cold water. This will disintegrate the flux. If the brazed joint is allowed to cool slowly, the flux usually sets into a hard vitreous film difficult to remove. A little sulphuric acid added to the water used for quenching greatly assists removal of flux and scale.

Manchester, England. A. EYLES.

Flashover Troubles Corrected on Rotary-Converter Commutator

WE HAVE a 500-kw. rotary converter at one of our railway booster stations that has always been sensitive to power-supply disturbances. It finally became so bad that the commutator would flash-over sometimes two and three tmes a day, with the usual damage to the brushes, rings and commutator.

Our first effort to correct the trouble was to give the entire machine a thorough cleaning. This machine is equipped with a full set of asbestos-board flash-barriers, and considerable copper was scraped off these where it had been embedded by the flashes. It was also found that the pilot brushes were too soft and tended to shatter. These were replaced with a harder grade, and the trouble was partially eliminated, but it started all over again in about four days.

A 1,500-volt, one-microfarad lightning arrester of the condenser type was obtained and connected in series with a 10-amp., 600-volt fuse directly across the commutator. The flashover trouble stopped, but the factory insulation between the commutator bars and clamping ring was so badly burned that it was decided to lengthen the path to ground and reinsulate the ring in one job.

A wooden ring was turned in four sections as shown by the dotted lines, Fig. 1, to match the steel clamping ring. The material was 1-in. well-seasoned oak. Four sections were used to obtain strength in cross-section. On large commutators, 15 or 20 sections might be required. Each piece was drilled with three holes and countersunk $\frac{3}{8}$ in. for $\frac{1}{4}$-in. flathead machine screws. Slight errors in the drilling made it impractical to have these pieces interchangeable, so we simply drilled and tapped the steel clamping ring to fit and fastened each piece in place before marking off the next one.

Pieces of canvas were clamped between the wood and steel rings, with the canvas hanging toward the center of the rings. After all screws were tightened a coat of shellac was applied to the outside surface of the rings. While this was sticky, varnish cambric tape was wound around, covering both rings until sufficient insulation was in place to equal that put on in the factory.

Another coat of shellac was applied, then the canvas was brought around the edge of the ring and tied temporarily with a cord. The cord band held the canvas in

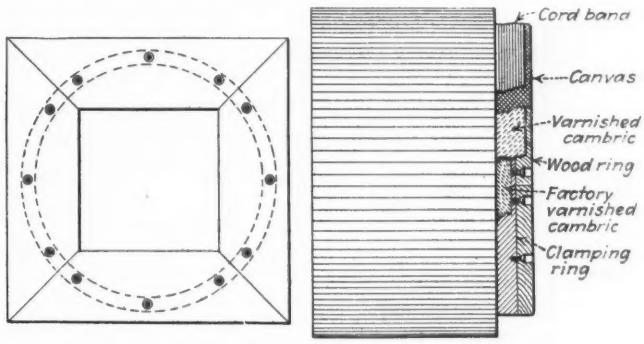


Fig. 1—Dotted lines show how woodring was made
Fig. 2—Insulation arrangement on commutator steel clamping ring

place while all wrinkles were drawn out to make a smooth job. Then, starting at the outside edge, a permanent cord band was put in place over the canvas.

Two thin coats of shellac were applied, then one thick one, after which the exposed canvas was ironed out with a hot soldering iron to harden it in order to prevent slinging of shellac. About two days later the first coat of red oil-proof insulating cement was applied. The second coat was given the next day and when it had dried the machine was started. We have had practically no flashover trouble since revamping this ring, and the insulation is still in good shape. THOMAS E. MILLER.

Nashville, Tenn.

Butted Piston Rings Cause Engine Trouble

A 50-HP. new gasoline engine had been erected and started to furnish 220-volt direct current for emergency light service. The writer had designed a water turbine to crank this engine, starting the turbine by a solenoid relay tripped by normal city current failure. The starting water turbine cranked the engine perfectly from cold. During some preliminary testing the engine was allowed to run and get rather hot and was then shut down. When the starter relay was tripped, the water turbine would not start the engine, in fact, would not even turn it over.

Hand cranking was tried, but the engine could not be turned over at all. The engine was allowed to cool and it started easily. After heating up in normal running, it was noticed that the speed and voltage decreased and the cylinder block became very hot. The engine was then shut down and allowed to cool after which dismantling showed that the ends of the piston rings had been butted and started cutting. When this was corrected there was no further trouble. J. S. CARPENTER.

York, Pa.

CURRENT COMMENT

Poor Welding Practice

I HAVE enjoyed the many special articles written in *Power*. Mr. Johnston's article in your December number is similar to many I have read on the subject of welding in pipe fabrication. It seems to me that he, as others have done, has distorted the facts in order to give more weight to his contentions.

I have no idea or intention to disparage Mr. Johnston's paper, or to question his veracity, or to condemn welded pipe installations. I think, however, that it is more important for a writer discussing welding to point out present poor and expensive welding practices, and to mention ways in which they can be eliminated, than it is to cite questionable advantages.

For example, Mr. Johnston states that one of the advantages of welding fittings is that stock and random lengths of pipe can be used and that less scrap pipe remains upon the completion of the job.

To me this advantage does not appear unique with welding fittings, but it also applies to screwed fittings. The amount of scrap pipe left after a job is finished is a direct reflection of the fitter's ability, whether screwed or welded fittings are used. The same is true of left-over fittings (either welded or screwed).

He also states that parallel pipe runs can be nested closer together when welding fittings are employed, as it isn't necessary to leave wrench room. He fails to mention, however, that torch room is necessary.

An article on eliminating present poor and expensive welding practices would certainly be interesting and widely read.

C. A. POPP.

New York, N. Y.

Hints for Doing Welding Jobs

HAVING read with considerable interest C. W. Hope's article on "Hints for Doing Welding Jobs" and the editor's note on copper welding in the December number, I would like to make a few comments on the welding of copper and cast iron.

Bronze welding is essentially a brazing process and is not to be confused with a fusion weld. In the former the base material is at no time in the molten state. The joint is made by the adherence of the spelter or brazing alloy to the base metal, which is assisted by using the proper flux, usually a compound of borax. In this process the base material is heated to a dull red and the flux and weld material applied. If the work is at the correct temperature, the metal from the rod will immediately spread out into a thin film over the base metal, but if the base metal is too hot or in a molten state the rod material will not flow. I am of the opinion that the difficulty Mr. Hope encountered was not the rotor bars conducted the heat away too fast but that the metal was overheated at the start. When he immersed the rotor in water the heat was carried away rapidly enough to maintain the bars at nearly the correct temperatures for bronze welding, which resulted in a satisfactory job.

Fusion welding of copper is difficult, unless de-oxidized copper is used. Commercial or electrolytic copper contains cuprous oxide which makes the metal weak and brittle. Molten copper absorbs oxygen rapidly, resulting in a bad weld that probably will fracture in cooling or handling. Welding with de-oxidized copper is the same as welding steel except that a larger tip is used on the welding torch and it is advisable to preheat and cover work with asbestos.

Bronze welding for cast iron has many advantages over a regular fusion weld using an iron filler rod. This method precludes the necessity for preheating and reheating, and with moderate care the most intricate castings may be readily welded. Any heating may be done with the welding torch or a kerosene torch and the weld made in thin layers each of which should be thoroughly peened before the weld metal has cooled. This peening will remove the stresses produced by cooling and contraction.

Arlington, Mass.

ELLIOTT MACDERMOND,
Inspector, Hartford Steam Boiler Inspection & Insurance Co.

Consider All Costs In Welded Piping

IT WAS with a great deal of interest that I read W. J. Johnston's article, "Welding Fittings" in the December number of *Power*. Accurate cost comparisons between welded and screwed pipe fabrications are of prime interest and importance to every user of piping. However, prejudiced comparisons are a nuisance and a menace to progress.

I take exception to Mr. Johnston's charts which compare the cost of welded construction to flange construction, as I believe that these charts should have also shown the cost of standard screwed construction. Flange construction is of course the most expensive type of screwed construction.

Mr. Johnston in enumerating the advantages of welding fittings states that no investment in threading machines is necessary, but does not mention the fact that it is necessary to have an investment in welding equipment. As a matter of fact a 4-in. die stock which can be driven by hand or power costs less than one common cutting torch.

One would assume from Mr. Johnston's article that suitable beveled pipe ends are always available. When pipe is cut and beveled by a hand torch, the resulting cut is not one to which a welding fitting can be accurately and cheaply welded. The uneven surface is not only likely to cause misalignment, but will also allow welding metal to penetrate into the inside of the pipe, causing a considerable reduction of passage. Machine-cut bevels are far, far superior to hand-cut torch bevels, but their use of course means an investment in a pipe-cutting machine which is not considered by Mr. Johnston.

In making comparisons between welded and screwed constructions, consideration must be given to the type of threading and cutting equipment used if the comparison is to be worthwhile. For example, it is possible to obtain

a 4-in. pipe threading, cutting and reaming machine that will make one 4-in. cut, one thread and one ream in less than a minute. A 4-in. beveled cut can be produced on this machine at a cost of less than 3c. A 4-in. bevel cut made by hand with a torch, considering gas, oxygen, and labor, will cost between 25c. and 30c.

Please let us have accurate, complete comparison!

Los Angeles, Calif. S. S. THORNBERRY.

Use Machine-Cut Bevels

I NOTICED a statement in an article on "Welding Fittings" by W. J. Johnson in your December number that I think should be taken with a grain of salt. The statement is: "The smooth internal surface, uniform contour of the bore and smooth junction of a welded fitting with an adjacent pipe give a lower pressure drop than in the case of a cast fitting"—(and the same ideas have often been expressed by other welding advocates.)

Theoretically, this is possibly true but I have seen many cases where a welded pipe joint caused a greater passage restriction than a screwed joint would have caused, assuming the pipe was reamed as it properly should have been. This restriction in each instance was the result of welding two torch-cut ends or the welding of a torch cut end to a beveled machine-cut end.

Cutting off and beveling pipe with a torch by hand is not only slow and expensive, but offers greater danger. When rough ends are welded together not only is alignment a problem, but the molten welding metal is apt to flow into the interior of the pipe, causing a restriction of capacity.

I recently saw a weld made by a demonstration expert on 6-in. pipe. The weld from the outside was perfect, but when the pipe was viewed from the inside it looked like the mouth of a shark. The welding metal projected into the interior in some places as much as $\frac{7}{8}$ in.

This trouble can be largely avoided by using only machine-cut ends. Portable hand cutters of the knife type made for handling pipe as large as 12 in. are extremely handy, and besides make a better cut and cheaper cut end.

Toledo, Ohio. R. W. WARNKE.

Bending Copper Pipes

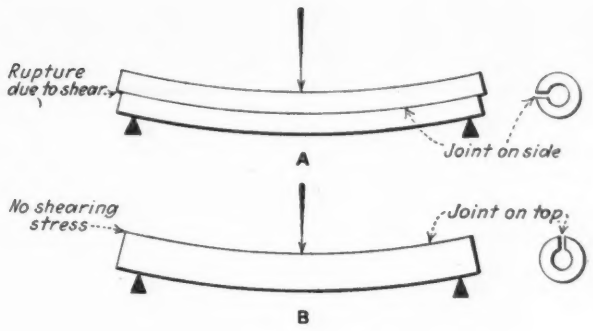
In the interesting letter in the December number of *Power,* by A. Eyles, page 312, the last sentence arrested my attention more than any other part of the letter. Very likely this is because my experience does not coincide with that of Mr. Eyles, who says, "When bending butt-brazed copper pipe it is good practice to locate the seam along its neutral axis or section to lessen the danger of rupture or cracking."

On account of the shearing stress that is set up when the pipe is deformed, as at *A* in Fig. 1, I have experienced the results shown in the sketch. This same action often occurs in wooden beams—they split along the neutral axis owing to their low resistance to shear along that axis in a direction parallel with the grain.

When the joint is on top as at *B* shown in Fig. 1, or on the bottom, there is no shearing stress. The fibres are in a state of compression when the joint is on top and in a state of tension when the joint is on the bottom.

I have had better success in the bending of pipe of this kind with the joint on the compression side.

While it is true, as stated by Mr. Eyles, that there



is a neutral axis located about midway between the inner and outer curves, and that the neutral axis is not subject to compressive or tensile stresses, the fact remains that at the neutral axis the shearing stress is a maximum. Brazed joints are notoriously weak in resisting shear. On the other hand, when the joint is either at the top or bottom there is no serious force tending to cause disruption. There is merely more or less internal disturbance due to compression or stretching of the fibres. Even this internal disturbance sometimes causes the joint to fail, but with less frequency than when the joint is at the side and subjected to the full shearing stress.

This experience is not entirely my own. Upon investigation I find that it is confirmed by the Research Department of one of America's largest manufacturers of brass and copper pipe, which also recommends that the braze be placed at the inside of the bend where the metal is in compression.

Atlantic Highlands, N. J. M. M. GOOCH.

Hints for Doing Welding Jobs

HAVING had considerable experience in similar welding jobs in our plant, I read with much interest the short article by Clarence W. Hope in the December number of *Power.* Connecting copper bars with bronze is not welding in the strict sense of the term, as it is more a process of brazing. By its use a bond can often be made on metal parts that will be as strong as the base metal.

Brazing copper bars to the rotor rings on squirrel-cage motors with modern silver solders can also be applied with equal success. Silver solder will often make joints that are stronger than the metals joined. This solder is remarkably fluid when in a molten state and it penetrates interstices that bronze would fail to fill.

The fundamental advantage of silver solder in repairing squirrel-cage motors is the freedom with which it will melt and flow into joints. Also, the strength and reliability of silver-brazed joints exceeds soldered or bronze-brazed joints. Emergency repairs to power-plant equipment can often be made satisfactorily by brazing with silver solder. It is essential, however, that the proper brazing alloy and flux be used. In one case, repairs to a 1,440-hp., 2,300-volt synchronous motor, operated at a speed of 514 r.p.m., comprised securing a large number of copper bars to retainer rings. Several materials were tried for brazing the copper bars to the copper retainer rings without success. Finally, a silver solder that permitted the job to be done quickly and satisfactorily was obtained. Since this experience, silver brazing has been adopted as standard practice for similar jobs throughout that plant. A. EYLES.

Manchester, England.

READERS' PROBLEMS

CHANGING A TWO-PHASE MOTOR FOR THREE-PHASE OPERATION—*I have a two-phase, 3-hp., 6-pole, 220-volt induction motor that has 36 coils connected two parallels, with a coil span of slots 1 and 6. It is desired to reconnect the winding for 220 volts, three-phase and the original speed. Can the winding be reconnected for the new condition, and if so, how should the coils be grouped and what should the span of the coils be? If the motor must be rewound, what size wire and how many turns in each coil? Will the motor be good for the same power rating when operating three-phase as for two-phase?*

A.L.C.

•

This winding, when regrouped for two-parallel star, will be good for 125 per cent of the two-phase voltage, or $220 \times 1.25 = 275$ volts. If one side of the coils can be lifted and spread made slots 1 and 5 the winding will be good for about 245 volts. Chording the coils to slots 1 and 4 will make the winding good for about 203 volts. If the 3-phase voltage is near 220 volts either one of the combinations will probably not be satisfactory. A factor that must be considered in this change is that chording the coils increases the distance that their ends extend out from the core and they may interfere with putting the end bells into place.

Another combination would be to reconnect the winding series-delta and chord the coils to slots 1 and 4, which would make the winding good for 230 volts. As previously mentioned, the ends of the coils may extend out to prevent putting the end bells into place.

If the motor is rewound there are several groupings of coils, number of turns per coil and size of wire that may be selected. Which will be best suited cannot be determined without knowing the number of turns and size of wire in the old coils. If the new winding is to be connected two-parallel star then rewind the coils with 80 per cent of the original number of turns, using wire 25 per cent larger. The coils should span slots 1 and 6 as in the two-phase winding.

REMOVING OXYGEN WITH CHEMICALS—*I understand that chemicals are sometimes used to remove oxygen from boiler water and thus reduce corrosion. Is this method satisfactory?* M.E.R.

Sodium sulphite has been fed to boiler feed water to remove oxygen from the water to prevent corrosion. The action of sodium sulphite is that of a reducing agent in accord with the following equation:

$$2Na_2SO_3 + O_2 = 2Na_2SO_4$$

Likewise ferrous hydrate has been fed to boiler water to remove the oxygen. It also acts as a reducing agent in the following manner:

$$4Fe(OH)_2 + O_2 + 2H_2O = 4Fe(OH)_3$$

Generally, where ferrous hydrate is used, it is formed by the reaction of lime or caustic soda with ferrous sulphate i.e., the lime and ferrous sulphate are fed independently to the water. An advantage, of sodium sulphite over the ferrous hydrate is that the product of reaction, sodium sulphate, is soluble, whereas ferric hydrate is insoluble.

In the feeding of either sodium sulphite or ferrous hydrate, consideration must be given to the fact that these substances are very rapidly oxidized in contact with the air. Dependence must, therefore, be placed upon tests of the treated water to insure the proper quantity to feed.

It is, of course, far more economical to remove the oxygen by heating the water to steam temperature in a properly designed deaerating heater than to do so by chemical means. Deaeration by heating is also more dependable, although on frequent occasions the use of reducing agents has been found helpful and practical for removing small amounts of oxygen from the feed water.

[The foregoing answer was prepared with the cooperation of J. D. Yoder, Cochrane Corp.—Ed.]

How to Find Out How Much Exhaust Steam Is Wasted

Answers to the January Question

The Question

IN OUR plant most of the power is generated as a byproduct of process steam. At times, however, there is a considerable waste of exhaust steam, some of which might be prevented by certain possible shifts in the power and process loads. We wish to install a device that will indicate at all times whether the atmospheric relief valve is open and if possible show how much steam is being wasted. I would like very much to get the suggestions of Power *readers.* S.W.P.

Prevent Waste Instead of Measuring It

IT IS my opinion, having seen similar cases, that there lies in this plant an opportunity for considerable saving. The given conditions afford an excellent chance to bring into play the standard type of back-pressure governor, assuming the generators to be turbine driven, and that any power swings in excess of the process load may be purchased.

Regarding the waste of steam to atmosphere, it seems unnecessary to install a flowmeter in this line just to know how much steam is being wasted. The fact remains that it *is* wasted, and whether 3,000 or 5,000 lb. per hr. go out the roof it should be prevented.

There are a number of ways to indicate whether or not the atmospheric valve is open. One method is to use an electric light mounted at some easily visible point and operated by any external moving valve part on which copper contacts may be mounted to close when the valve opens. If there are no external moving parts on the valve, a $\frac{1}{4}$-in. hole, drilled in the atmospheric line just above the valve, may be used to mount a thermostatic element which escaping steam will expand to light the light. HARRY M. SPRING.

Milford, N. J.

Flowmeter Measures Exhaust

BACK in 1924 the writer encountered a similar problem in a large chemical plant using exhaust steam from prime movers such as steam-driven ammonia compressors and turbo-generators. These prime movers exhausted against 25 lb. back pressure into a header line that delivered the steam to the vacuum evaporators.

At one end of this header a 6-in. live-steam make-up line was connected from the 150-lb. high-pressure steam header. At the middle of the header a 12-in. atmospheric relief line was connected to relieve any excess pressure over 25 lb. to the atmosphere. Process steam requirements varied considerably at times and a very considerable amount of steam was wasted. As the plant was on a 24-hour daily schedule and fuel costs were high, it was imperative that such loss be eliminated as far as possible.

On being called in to make recommendations, I suggested the use of a well-known steam flow meter of the electric type with an orifice plate in the 12-in. atmospheric relief line. The meter capacity was figured at 30,000 lb. per hour, as this would permit handling most any condition that could arise due to variation in process steam requirements.

The graphic recording meter panel was located adjacent to the evaporator steam valve controls, directly under the operator's observation. Thus he could see immediately whether any steam was flowing to atmosphere and could regulate his conditions accordingly to eliminate the steam waste. This worked out satisfactorily and led to the use of another meter on the live steam make-up line. We located the graphic recording panel of this make-up steam beside the panel for the relief-line steam so that the operator knew at all times the steam being required for make-up and whether any was wasted to the atmosphere. The arrangement of meters selected lends itself readily to the use of electric alarm attachments if it is decided to install them at a later date.

GUY L. WARDEN.

Los Angeles, Calif.

Uses Orifice to Measure Exhaust

WE HAVE two 30-in. and one 36-in. atmospheric exhaust lines with automatic reliefs. Our power is generated as a byproduct of process steam, with considerable exhaust to atmosphere at times.

To measure the exhaust we have installed orifice plates and electric recording meters on each line. We further installed a large dial indicator visible from the switchboard, at which point the load on the units is controlled. We have been able to effect large savings by using both the recorded and indicated data.

An installation of this kind will cost S. W. P. $400 to $600, depending on the size and location of his line and whether or not he wants both the recorder and the indicator. A somewhat cheaper installation can be made by placing an orifice plate in the exhaust line with taps for a U-bend differential manometer using colored carbon tetrachloride. Proper choice of orifice diameter and tap locations will give readings in pounds of steam per hour

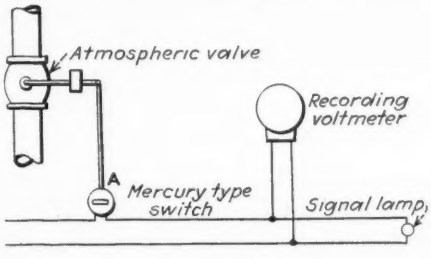
L. J. SFORZINI.

Rochester, N. Y.

Install Switch to Operate Alarm

SINCE the type of valve in use was not mentioned it is difficult to make specific recommendations. But there are several possibilities that suggest themselves.

If the valve is of the weight-loaded type with a lever and weight on the valve mechanism, the most positive method of giving an indication would be to attach some device similar to the one shown in the accompanying sketch.



The mercury-type switch *A*, actuated by means of the lever arm, closes the circuit when the valve opens and causes a lamp to glow. If it is desired to have a permanent record of the number of times the valve operates during the day, a recording voltmeter may be connected across the line as shown. Then when the valve operates and the switch closes the circuit, the pen arm will move out on the chart and hold at a steady value until the valve closes. Then the pen arm returns to zero.

If the valve is not constructed so that a switch mechanism may be attached to its moving parts the element of a recording thermometer may be inserted in the line on the discharge side of the valve. When the valve opens and steam flows in the discharge line around the element, an indication will be given on the chart, since the pen arm will move out sharply due to the increase in temperature. The pen arm will return to a lower point when the valve closes. An alarm signal may also be attached to this type of meter so that when the pen arm moves out due to the increase in temperature it will also close a circuit and sound the alarm.

Of course, neither of these methods will record the amount of steam wasted when the valve is open. It would not be practical to install a recording flow meter because it would not give satisfactory results due to the intermittent flow and the varying density of the steam. The quality of the steam could be determined experimentally and an average quality used in approximating the flow through the valve. If the velocity of the steam is obtained from pitot tube readings, then the weight of steam is $W = AdV$ where $W =$ weight in lb. per sec. $A =$ cross sectional area sq. ft. $d =$ density of steam lbs. per cu. ft. $V =$ velocity of flow ft. per sec.

Bellerose, L. I. H. C. OATLEY.

Two Questions for Our Readers

Question 1

Upon inspecting the boilers of a plant that I recently took charge of, I found considerable oil had been deposited in them, the oil coming from steam engine exhaust due to the fact that equipment for separating the oil from the steam had become clogged and ineffective. I would appreciate suggestions for a device that will indicate when the steam after it leaves the separator or the feedwater has excessive oil in it so that steps can be taken to overhaul the oil separator before the boilers become so fouled as to require cleaning. P.H.S.

Question 2

We are planning to install a 100-ton refrigerating plant, the machine to be driven by direct-connected oil engines. Demand varies over a fairly wide range. Should we install two compressors driven by separate engines or a single engine-compressor set which would run at half speed when demand is low? Or would two separate diesels one half the size of the other and both clutched to the same compressor (larger taking peak load, lower taking low) work out best? L.E.C.

Suitable answers from readers will be paid for if space is available for their publication.

Flow Characteristics of Valve From Manufacturer

I ASSUME from the question that the atmospheric valve under consideration is a multi-port atmospheric valve. This type of valve is usually located near the roof and operated by a chain from the operating floor. From a wide-open position to a closed position for a 10-in. valve requires about 150 in. of motion of the chain. At one plant we installed a vertical board marked every 3 in. The board shows the $\frac{1}{4}$ in. open, $\frac{1}{2}$ open, $\frac{3}{4}$ open, and full-open positions of this valve. These atmospheric valves are set to open at a certain predetermined pressure depending on the size of the valve and the pressure of the springs.

By giving the manufacturer the size and type of the valve it is possible to obtain the approximate amount of steam flow at various pressures and positions of the valve. Then, with the bulb of a recording thermometer placed in the pipe on the exhaust side of the atmospheric valve, it is possible to tell when the valve is open and for how long a period. By knowing the average steam pressure, average position of the valve, and the number of times the valve is open and for how long a period, it will be possible to estimate the steam lost to the atmosphere. Of course, elaborate metering equipment could be installed in the high-pressure side of the valve, but I believe the foregoing simple and relatively inexpensive indicator and thermometer will serve satisfactorily.

Parlin, N. J. G. L. C. LINN.

HIGHER PRESSURES & TEMPERATURES

A Challenge to Engineers

By MELVIN D. ENGLE and IRVING E. MOULTROP*
Ass't to Supt., Station Engrg. Dept. *Chief Engineer*
The Edison Electric Illuminating Co. of Boston

THE END has not yet been reached in the application of high pressures and temperatures to central stations; the optimum steam pressure and temperature for steam-electric generating stations has not been determined. Fig. 1 compares station heat rates at various temperatures and pressures. It shows that higher temperatures mean better station economy, regardless of the pressure or cycle used.

Some of the new stations now being built will operate at 825 to 850 deg. F. Within a comparatively few years we will, no doubt, be operating with steam temperatures of 1,000 deg. F. We could probably design for nearly 1,000 deg. today, if closer control of the temperature of steam leaving superheaters and reheaters were possible. This problem is being studied, and seems well on the way to a solution.

Fig. 2 shows how the station heat rate at constant temperature falls as the pressure rises from 400 lb. to 2,500 lb. No matter what steam temperature one selects, the higher steam pressure shows considerable improvement in station economy when compared with the so-called "moderate" pressure of 400 lb. The improvements in economy for pressures at least as high as 1,200 lb. are of such magnitude that station designers cannot afford to disregard them.

A number of designers seem to favor a pressure of from 600 to 700 lb., and a temperature from 825 to 850 deg. F., without reheat, on the plea that such a station gives good economy and is simpler than one employing the reheat cycle. It is true that such a station will give approximately 5 per cent better economy than a 400-lb., 850-deg. station, but the designer should not overlook the fact that on the same basis a 1,200-lb., 850-deg. reheat cycle will give approximately 13½ per cent better economy than the 400-lb., 850-deg. station.

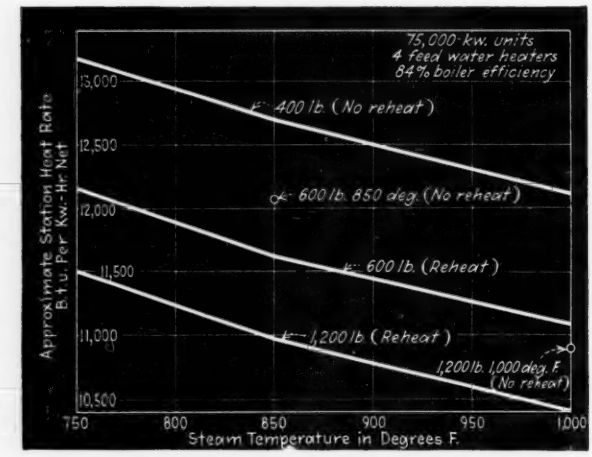


Fig. 1—Comparison of approximate station heat rate at constant pressure and varying steam temperatures

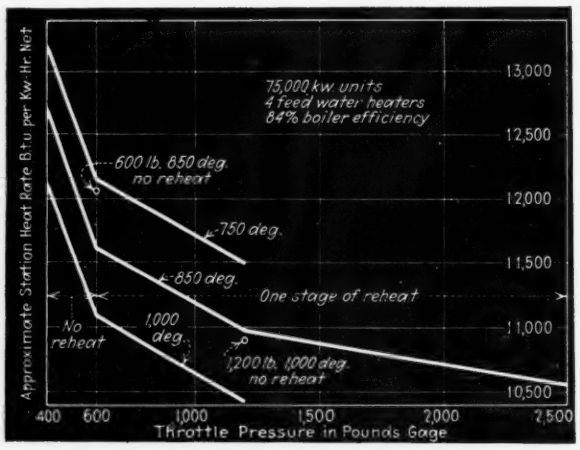


Fig. 2—Comparison of approximate station heat rate at constant temperature and varying steam pressure

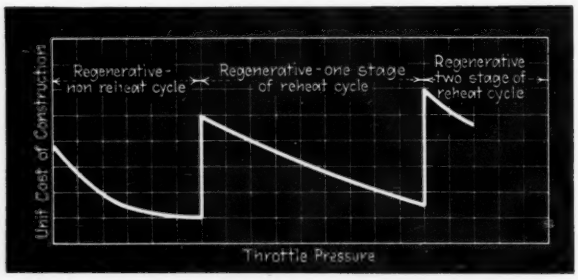

Regenerative - non reheat cycle
Regenerative - one stage of reheat cycle
Regenerative two stage of reheat cycle
Unit Cost of Construction
Throttle Pressure

Fig. 3—Probable variation in unit cost of construction of steam-electric generating station at constant temperature and varying pressure

▼

*Digest of a paper read before the A.I.E.E. annual meeting in January.

The reheat cycle has given no serious operating trouble. The question, then, boils down to that of unit cost. Past experience shows that higher steam pressure does not in itself increase the cost of construction, but actually lowers it. The probable fact is that the unit cost of construction decreases with increase in pressure, as long as the same heat cycle is employed, and as long as the pressure does not require a radical change in the design of the pressure apparatus. When such a point is reached the cost takes a sudden jump, but falls off again as the pressure is increased, until another change in heat cycle or design is necessary. The idea is illustrated graphically by Fig. 3.

Fig. 5 shows the additional capital investment per unit of capacity that is justified for a 1,200-lb., 750-deg. reheat station over a 400-lb., 750-deg. non-reheat station for 40 per cent load factor and various costs of fuel. It will be noted that a considerable increase in unit cost is justified by the higher thermal efficiency.

Moreover, if we can promote the development of high-pressure equipment without actual financial loss, by the use of equipment that is economically justified at its present price, we aid in the progress of the art, and will reap even greater profits in the future.

The possibilities of the series type of steam generating units should have further study, and probable commercial trial in the United States. Such boilers are in service in Europe and operating with some degree of success. The series boiler and superheater may be the answer to our need for superheat control for higher temperatures, and may have possibilities that we do not realize at this time.

Fig. 4, showing one of the latest designs offered for a 1,400-lb. pressure boiler, shows the great change that has taken place in design through the re-

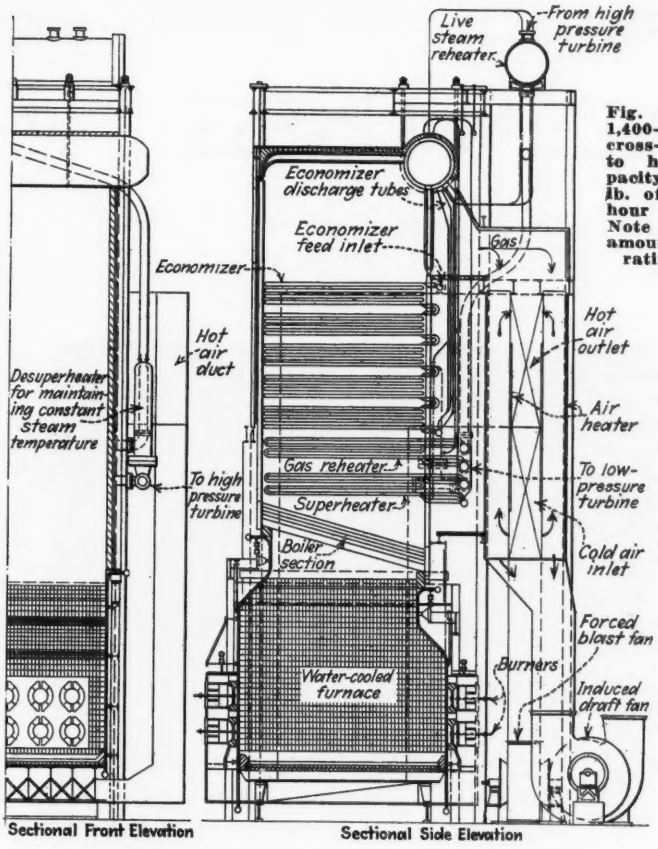


Fig. 4—Proposed 1,400-lb. pressure cross-drum boiler to have a capacity of 25,000 lb. of steam per hour per section. Note the small amount of evaporating surface

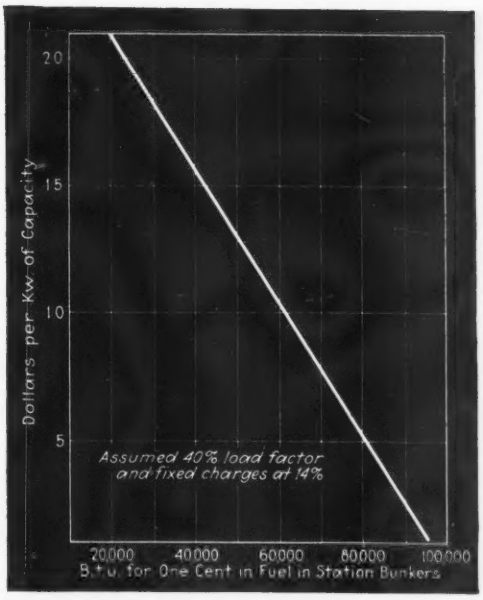


Fig. 5 — Additional capital justified for 1,200-lb., 750-deg. station over 400-lb., 750-deg. station.

cent high-pressure steam revolution.

High-pressure boiler feed pumps of 2,000-g.p.m. capacity are now available. Most of the difficulties experienced to date with high-pressure feed pumps are due to the lack of suitable variable-speed, 3,600-r.p.m., a.c. motors, and to the high temperature of the water. Another difficulty has been that of obtaining sound steel castings.

In deciding what steam pressure to use in future construction, we should keep in mind that considerably greater capacity can be installed on a given piece of property if the station is designed for the higher pressures. In particular, high pressure greatly increases the capacity that can be obtained from a given amount of circulating water, or for a given expenditure in the construction of intake and discharge tunnels, where these are costly.

Where existing stations are to be remodeled or extended, high-pressure equipment will permit greater capacity to be installed in the existing buildings and will increase the economy of the whole station much more than the difference in economy between the high-pressure equipment and the existing equipment.

From a consideration of these facts, we can safely say that engineers in the future will meet the challenge of past accomplishments, and will build steam-electric generating stations that will show considerably better fuel economy than our present stations, and, furthermore, will cost considerably less per unit of capacity.

ENGLE-MOULTROP PAPER STIRS UP DISCUSSION

● EXTENDED discussion following presentation of the A.I.E.E. paper of Engle and Moultrop (reported above), demonstrated keen interest in high steam pressures and temperatures. Frequent references were made to Mr. Moultrop's pioneer work in this field. The opinion was generally expressed that 1,400-lb. pressure has proved its economic value.

Dr. D. S. Jacobus of the Babcock & Wilcox Company mentioned B. & W.'s extended work on "series" boilers, but hinted at pioneer work still required for commercial units of this type. The welding of high-pressure drums, he said, will come soon with the development of procedure to weld the 75,000-lb. tensile steels generally used.

The additional cost of a 1,400-lb. central station runs from $5 to $10 per kw., Geo. A. Orrok stated. He predicted maximum economic pressure of 1,800 to 2,000 lb. for high load factors and 600 to 900 lb. for low.

Dean A. A. Potter of Purdue wrote in that the fluid friction of steam at high pressures is being investigated at that institution. He invited suggestions.

It would pay, for the present, to standardize on 1,200 lb. pressure, wrote G. G. Post, vice-president of the Milwaukee Electric Railway & Light Company. Standardization, he said, will cut equipment costs. To illustrate the advantage of high pressure he said that raising the pressure from 300 to 1,200 lb. cuts fuel 15 per cent at an investment cost of $5 per kw.

A. C. Weigel, Combustion Engineering Corporation, said that seamless forged drums represent half the cost of a high-pressure boiler. He outlined developments in drum welding.

G. L. Knight, vice-president of Brooklyn Edison, said that conservative pressures, requiring no experimentation, may be necessary when capacity additions must be operating at a specified date. He said that the two latest 160,000-kw. turbines at Hudson Avenue generated 1.3 per cent of the whole U. S. utility output for 1932.

The utilities, according to G. Warren of General Electric, are overlooking many possibilities of dumping low-cost byproduct power into their lines. Industry, he said, provides a better exhaust-heat sump than the river.

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Diesel Engine Operating Report Correction

● ON PAGE 19 of the January number of POWER, there are given two operating reports on diesel engine installations. The final column in each is listed as "Total Diesel Cost Including Fixed Charges." This heading, which is that supplied by the source of the information, is incorrect and should read, "Total Operating Costs," since no allowances have been made for interest and depreciation, and thus the fixed charges are not included.

TEST METHODS FOR DETERMINING

CONDENSER CLEANLINESS[1]

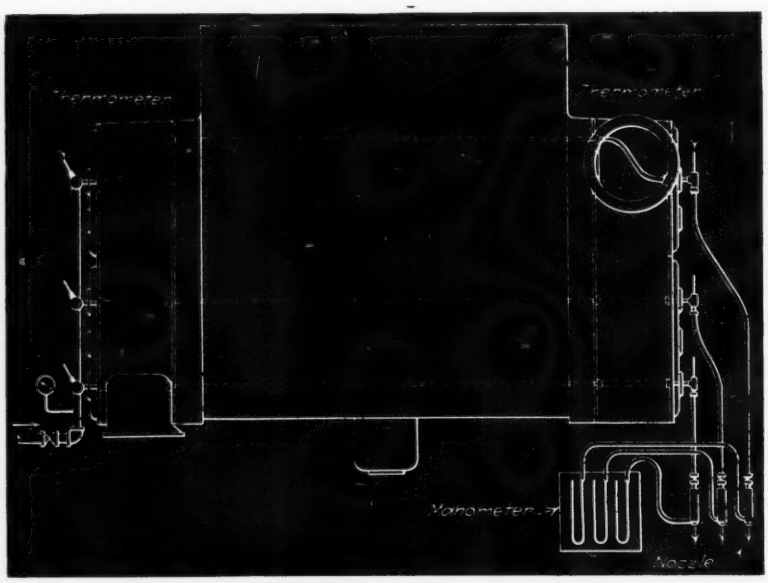
By P. H. HARDIE and W. S. COOPER

Brooklyn Edison Company

AN EQUITABLE basis for making condenser guarantees has been in most cases impossible because of the lack of a reliable method for determining the condenser cleanliness factor. If condenser performance is to be correctly appraised it is just as important to know how clean the condenser tubes are as to know the circulating water temperature and velocity. The quantity of scale or slime on the tube surface is not in itself a direct measure of the reduction in performance. Therefore attempts to estimate a cleanliness factor by visual inspection of the tubes cannot be considered as being any better than rough guesses.

For a given water velocity, cleanliness factor is the ratio of the heat transmittance of a fouled tube to that of a new tube through which water has been passing only the short time necessary to get the test started. The two tubes must be supplied with circulating water at the same inlet temperature, and the velocities through the tubes must be equal. Similarly, the tubes must be subjected to the same conditions on the steam side.

Measurements of tube cleanliness factor can be made in two ways: first, by isolating the test tubes and testing them in place in the condenser; second, by removing the selected tubes and testing them in a calorimeter. Both methods have their good points, but the authors consider the test in place preferable.



Arrangement of test apparatus for determining cleanliness factor with tubes in place

The data required for an evaluation of the cleanliness factor are the tube's cylindrical area, the enveloping vapor temperature, the inlet and the outlet temperature of the cooling water, and the rate of flow of the water. Cleanliness factor data are observed simultaneously with the over-all condenser data. This procedure provides a continuous record of variations in cleanliness factor throughout the test.

For the test on single-pass units, the selected test tubes were isolated in place by means of rubber hose jumpers which carried their cooling water supply across both water boxes. Rubber hose has the advantage of insulating the test tube water from temperature effects of the water in the boxes. On the inlet end the test tubes were connected through the water box cover to a distributing manifold receiving water from the same source as for the entire condenser. With this arrangement water of the same quality and very nearly the same temperature as at inlet to the condenser was available. A "master valve" installed in the supply line to the manifold served to regulate the supply pressure to the values required by the test. The outlet end of each test tube was connected with

Cleanliness Factor Data

Run No.	1		5		6		9	
Duration of Run-hrs	1.0		1.0		1.0		1.0	
Load-Btu. per hr. per sq. ft.	6770		5260		9140		12690	
Steam Press — in. Hg. abs.	1.09		0.93		1.36		1.82	
Steam Temp. — deg.F.	81.7		76.7		88.6		98.0	
Tube Condition	U	CF	U	CF	U	CF	U	CF
New	837	....	796	....	858	....	853	....
New	877	1.00	825	1.00	882	1.00	870	1.00
Old	611	0.70	583	0.71	547	0.62	531	0.61
Old	590	0.67	576	0.70	554	0.63	545	0.63
Old	567	0.65	546	0.66	518	0.59	509	0.59
New	645	....	602	....	572	....	585	....
New	616	1.00	615	1.00	612	1.00	623	1.00
Old	445	0.72	416	0.68	407	0.67	394	0.63
Old	456	0.74	433	0.70	410	0.67	391	0.63
Old	420	0.68	395	0.64	385	0.63	374	0.60
New	914	....	871	....	911	....	904	....
New	869	1.00	826	1.00	881	1.00	890	1.00
Old	537	0.62	496	0.60	461	0.52	440	0.49
Old	562	0.65	539	0.65	484	0.55	455	0.51
Old	589	0.68	568	0.69	500	0.57	475	0.53
New	771	....	708	....	786	....	786	....
New	772	1.00	725	1.00	795	1.00	804	1.00
Old	523	0.68	483	0.67	482	0.61	460	0.57
Old	455	0.59	418	0.58	435	0.55	426	0.53
Old	469	0.61	430	0.59	460	0.58	457	0.57
New	660	....	621	....	666	....	670	....
New	651	1.00	618	1.00	671	1.00	679	1.00
Old	458	0.70	422	0.68	415	0.62	408	0.60
Old	476	0.73	458	0.74	420	0.63	407	0.60
Old	462	0.71	422	0.68	421	0.63	412	0.61
New	541	....	500	....	512	....	566	....
New	533	1.00	485	1.00	567	1.00	582	1.00
Old	381	0.71	368	0.76	354	0.62	366	0.63
Old	437	0.82	400	0.82	416	0.73	411	0.71
Old	414	0.78	388	0.80	394	0.69	385	0.66
Average								
New (1)	728	....	683	....	718	....	727	....
New (2)	720	1.00	682	1.00	735	1.00	741	1.00
Old	492	0.68	463	0.68	448	0.61	436	0.59

NOTE — No. 1 Tubes supplied with city water, all others with salt water.
U = Heat transmittance.
CF = Cleanliness factor.
Inlet water temp. 62 deg.F., velocity 8.3 ft. per sec.

[1]Abstract of paper presented at meeting of A.S.M.E. Metropolitan Section.

rubber hose to a control valve, and nozzle for measuring the water flow through it.

Each nozzle was given a weighed flow calibration over the range of flows expected. Fig. 1 shows diagrammatically the flow circuit for test tubes installed in a single-pass condenser.

Mercury thermometers inserted directly into the water stream through rubber stoppers were used to indicate the inlet and outlet temperatures of each tube. Where several tubes are tested in a group, only one inlet thermometer per group need be used, but a thermometer is required in the outlet of all tubes.

The question of selecting test tube locations that will represent the condition of an entire condenser in regard to fouling is one of importance. The number of old tubes required to determine the cleanliness factor for any given condenser depends on the size of the condenser, the layout of the tube bank, and the uniformity of fouling. The more uniform is the distribution of fouling, the more nearly will a limited number of sample tubes represent the condition of the entire tube bank. As an expedient in producing uniformity of fouling, the condenser tubes should be cleaned just prior to the test by the customary method in use in the plant. Eighteen old tubes and six new tubes have been found by the authors to be adequate for large condensers.

Two general schemes of test tube arrangement have been used. With the first arrangement, a "single group" located near the top of the tube bank is used. The group contains one or more new tubes installed just prior to the test, and several other old tubes, which have been removed from various representative parts of the tube bank and reinserted in this group. The second scheme, known as the "multiple group" method, consists in selecting several groups of tubes at various representative positions in the condenser's tube bank, and testing them in place. Each group contains one new tube and one or more old tubes which have been in continuous service up to the time of the test.

The heat transmittance of the old and new tubes was computed from the following equation:

$$U = \frac{WC}{S} \log_e \frac{T_a}{T_b}$$

where U = heat transmittance, B.t.u. per hr. per sq.ft. per deg.
W = water flow—lb. per hr.
C = specific heat of water.
S = surface area per tube—sq.ft.
T_a = initial temperature difference.
T_b = terminal difference.

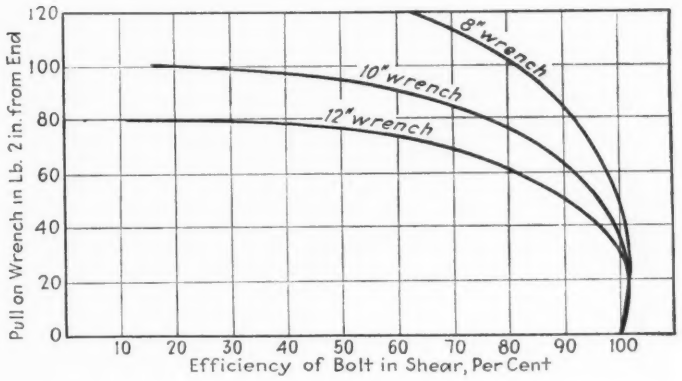
Performance of the test tubes should be referred to the saturated vapor temperature corresponding to the absolute pressure adjacent to them. For those test tubes located well down into the tube bank, there is an appreciably lower vapor temperature due to the vapor pressure drop across the tube bank. Referring the performance of these test tubes to the vapor temperature at the condenser neck, results in cleanliness factors which are higher than the true value. For condensers having low pressure drop, the error is small, and this simplification is justifiable.

The table shows the results of cleanliness factor tests on a single-pass condenser having 101,000 sq.ft. of condensing surface.

The cleanliness factor is different for different water velocities through the tubes. This is as it should be according to theory, and is explained by the fact that the heat transmittance varies with some power of the velocity, and the exponents for new tubes are higher than for old tubes. Cleanliness factor decreases with increasing water velocity.

PROPER SIZE WRENCHES

FOR TIGHTENING NUTS ON BOLTS



Relation between efficiency of a bolt in shear and pull on wrench used to tighten its nut

In *Contact* of the New England Power Association there appears an article, "Care Important in Tightening Tower Bolts," by C. A. Booker, which, although dealing with bolts in transmission towers, is applicable to bolts in any application where they are stressed after being tightened. It was found that bolts in tower crossarms failed during the application of test loads. An inquiry among the workmen who assembled the towers developed the fact that the nuts had been tightened with wrenches which were too long. This resulted in high initial stress in the bolts and premature failure when the structure was loaded.

With this conclusion as a starting point, an attempt was made to analyze the reasons for the bolt failure. About 85 per cent of the effort used in tightening the nut is wasted in overcoming the friction of the surfaces in contact, and only about 15 per cent of the effort is expended in actually tightening the nut. If friction were entirely absent, a small boy could, without difficulty, draw a nut up so tight that a $\frac{5}{8}$-in. bolt would pull apart at the root of the threads, since a force of only 25 lb. applied at the end of a 10-in. wrench is all that is necessary to cause this failure. The large amount of effort needed to overcome friction, as related to the effort necessary to tighten the nut, also explains why after the nut is tightened it does not immediately back off the bolt when the pressure on the wrench is released.

When two structural members are to be bolted together so as to transfer a stress from one to the other, this is generally accomplished by having the bolts so placed as to act in shear. The holding power then is developed partly by friction of the bolt against being cut off by the scissors action of the two surfaces. Studies of the holding power of bolts under varying tightness of the nut resulted in the curves that indicate there is a happy medium in the tightness to which a nut can be drawn in order to achieve best results.

The following sizes of wrench will develop about the ideal tension in the ordinary bolt if taken up with a pull of about 75 lb., that is, just what a husky lineman would call "snug":

Bolt Sizes Inches	Wrench Length Inches
$\frac{1}{2}$	7
$\frac{5}{8}$	10
$\frac{3}{4}$	14
1	20

In the case of a bolt working in tension, such as an anchor bolt on a concrete footing, it makes no difference in the ultimate holding capacity of the bolt what initial tension may be applied. So long, of course, as this tension is within the elastic limit of the steel, additional torque may be developed by using the longest wrench available on bolts exceeding one inch in diameter.

THE ENGINEER'S BOOKSHELF

The What and Why of pH

pH AND ITS PRACTICAL APPLICATIONS. *By Frank L. La Motte, W. R. Kenny and A. R. Reed. Published by the Williams and Wilkins Company, Baltimore, Md. Cloth, 6x9 in., 270 pages, illustrated. Price $3.50.*

Certain symbols, such as "kw." and "B.t.u.," have won dominant positions in industry. To this group has been added "pH." Not only in the "chemical industry" proper, but in every branch of industry that uses chemistry, pH as a measure of hydrogen-ion concentration, and hence of acidity, is finding numerous important applications. Several years ago it began to play a prominent part in discussions of feed-water treatment and boiler-water conditioning. The idea of pH may be a little hard to explain, but its determination and use are simple and practical operations that appeal to the man on the job.

Section A of the book explains the meaning of this unit and the action of hydrogen and hydroxyl ions, and shows how pH values are determined.

Nearly 200 pages are given to the practical applications of hydrogen ion determinations in industry and science. One chapter is devoted to water corrosion problems, another to municipal and industrial water supply. Other industrial applications covered include: waste disposal, sugar, gelatin and glue, leather, textiles, pulp and paper, food, electroplating, bacteriology.

X-Ray Analysis

APPLIED X-RAYS (Second Edition). *By George L. Clark, professor of Chemistry, University of Illinois. 484 pages, 6x9 in. 225 illustrations. Indexed. Clothboard covers. Published by the McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y. Price $5.*

What X-rays are, how they may be used, what results they produce, why they can be applied to practical problems and how industry is beginning to use them—these are the subjects of this standard text. This new edition is twice the size of the previous one and covers developments of the last six years. The entire second part of the work, some 300 pages, is devoted to X-ray analysis of the ultimate structures of materials. Power engineers will be particularly interested in Chapter XV, "The Structure of Alloys," and Chapter XVII, "Practical Applications of X-rays to Problems of the Metallurgical Industry."

BRIEF REVIEWS

BONBRIGHT SURVEY OF ELECTRIC LIGHT AND POWER COMPANIES OF THE UNITED STATES *(Ninth Edition, Revised to October, 1932). Arranged according to Geographic Divisions. Edited by G. F. Wittig, Statistical Editor. ELECTRICAL WORLD and J. A. Stuart, ELECTRICAL WORLD. McGraw-Hill Publishing Co., Inc., New York, N. Y. 192 pages. $10.*—Ninth annual issue of a directory of electric light and power service in places of 2,500 population or more, listed alphabetically by states, with a key map and table for each state, picturing electric utility holdings. List of holding corporations and subsidiary companies in corporate structure. Indication of the source of energy purchased in bulk by municipal systems and distributed over municipal lines constitutes an innovation in the present edition.

INTRODUCTION TO TECHNOCRACY. *By Howard Scott and others. 61 pages, 5½x8¼ in. Paperboard covers. Published by The John Day Co., Inc., 386 Fourth Ave., New York, N. Y. Price $0.90.*—Two principal parts, Part I, "The Technologist Looks at the Depression" and Part II, "Integrating the Physical Sciences in Attacking Social Problems," plus a foreword by the "Continental Committee on Technocracy" some basic definitions and a selected reading list comprise this volume. Howard Scott wrote only Part II, which is a reprint of a part of an article in *The Living Age* and is considered basic to an understanding of Technocracy.

Mirroring the general confusion, misstatement and informational unreliability of public utterances of proponents of Technocracy, this thin volume is worth its price to any engineer, both for the understanding —if that is possible—of this new science and for the reasons which led to its spectacular rise and sudden apparent eclipse.

FREON (Dichloro-difluoro-methane, [$C Cl_2 F_2$] also called F-12 and K-12, the new refrigerating gas). By E. T. Williams, consulting engineer, Servel, Inc., and John Kenlon, consulting engineer. 374 pages, 8½x11 in. Paper covers. Illustrated. Published by Servel, Inc., 51 East 42nd St., New York, N. Y. Price $2.50—This publication is a compilation of several briefs on the refrigerant "Freon" and its physical and physiological properties established by authoritative tests.

SMITHSONIAN INSTITUTION ANNUAL REPORT FOR 1931—Published by United States Government Printing Office. For sale by the Superintendent of Documents, Washington, D. C. Cloth, 6x9 in., illustrated, 592 pp. Price $2.

CARBONIZING PROPERTIES AND CONSTITUTION OF WASHED COAL—The U. S. Bureau of Mines, Department of Commerce, has issued four bulletins by A. C. Fieldner, J. D. Davis, R. Thiesen, E. B. Kester, W. A. Selvig, D. A. Reynolds, F. W. Jung, and G. C. Sprunk. Technical Paper No. 519 deals with coal from Mary Lee bed, Flat Top, Jefferson Co., Ala. Technical Paper No. 524 deals with No. 6 bed coal from West Frankfort, Franklin Co., Ill. Technical Paper No. 531 deals with Black Creek bed coal from Empire Mine, Walker Co., Ala. Technical Paper No. 525 deals with Pittsburgh bed coal from Edenborn Mine, Fayette Co., Pa. These papers may be obtained from the Superintendent of Documents, Washington, D. C. Price, 10 cents each.

A.S.T.M. STANDARDS—The 1932 edition of the A.S.T.M. Tentative Standards has been published by the American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa. It includes 39 on ferrous metals, 20 on non-ferrous metals, 31 on cement, lime and clay products, 25 on preservative coating, and 15 on petroleum products and lubricants. Among the total of 226 listed, 47 are new. 1,236 pages, bound in blue cloth. Price, $8. Copies in heavy paper. $7.

A.S.T.M. PROCEEDINGS—American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa., has issued 1932 Proceedings in two parts, the first including the annual reports of the many committees, and Part II the technical papers, comprising together 1,895 pages. Prices per part are: Paper binding, $5.50; cloth, $6; half-leather, $7.

DUST—A paper, "Dust and Fume Emission from Power Station Chimneys," by J. W. Gibson, has been published by Davidson & Co., Ltd., Belfast, Ireland.

R.F.C.—"Financing the Construction of Self-Liquidating Public Projects through the Reconstruction Finance Corporation"—A 10-page, paper-backed booklet containing the substance of an address by Harvey Couch, a director of the R.F.C. Printed by the U. S. Government Printing Office and available from the Superintendent of Documents, Washington, D. C.

MUNICIPAL WATER WORKS—Rates, Revenues and Results of Municipal Ownership of Water Works in the United States, by R. E. McDonnell, has been published by Burns & McDonnell Engineering Co., Kansas City, Mo. Price, $1.

MCGRAW-HILL BOOKS—The 1933 Catalog of McGraw-Hill books, including approximately 175 headings in a wide variety of engineering and associated fields, is now available from the McGraw-Hill Book Co., 330 West 42nd St., New York City.

A.S.T.M. SPECIFICATIONS—The American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa., has issued three sets of tentative specifications, the first on Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes, the second on Gray-Iron Castings, and the third on Method of Sampling Coke for Analysis.

FUSION WELDING—A mimeograph on "Investigation of Fusion Welding" by the Hartford Steam Boiler Inspection & Insurance Co., Hartford, Conn., reports the results of an investigation of sample welded plates, showing physical properties which may be expected in modern welding.

COLLOIDAL GRAPHITE LUBRICATION—Acheson Oildag Co., Port Huron, Mich., has issued a technical bulletin on the mechanics of lubrication with colloidal graphite. It is known as No. 200.2.

INTERNAL COMBUSTION ENGINES—Nos. 86 and 87 of the Reports of the Aeronautical Research Institute, Tokyo Imperial University, Japan, discuss "A New High-Speed Indicator for Internal Combustion Engines," and "On the Balancing of Two-Stroke 12-Cylinder Engines."

OIL ENGINE TRACTION—A series of lectures by Alan E. L. Chorlton, delivered before the Royal Society of Arts. May be obtained from the Royal Society of Arts, John Street, Adelphi, London, W. C. 8. Price, 3s.

THE THERMODYNAMICS OF CO_2 CYCLES—By A. B. Stickney. Reprint of technical paper presented before Annual Meeting of A.S.R.E. Available from Fred Ophuls & Associates, Inc., consulting engineers, 112-114 West 42nd St., New York City. 9 pages, 9x12 in. Discusses the thermodynamics of the various cycles for the manufacture of solid CO_2. Points to factors governing each cycle for a given set of temperature conditions. Compares cycles with each other and with the Carnot Cycle. Numerous charts and diagrams.

INDUSTRIAL REHABILITATION—The Committee on Industrial Rehabilitation, 435 Seventh Ave., Pittsburgh, Pa., one of the Government committees appointed recently, has issued a booklet, "Rehabilitation—What's in It for You?" and a check sheet, available from the above address or from district chairmen.

WIRTSCHAFTLICHE ENERGIEVERTEILUNG IN DREHSTROMKABELNATZEN (Economics of Distribution by Three-Phase Cable Networks), by Dr.-Ing. Willy Speidel. 124 pp. 17 illus. Seven tables, published by R. Oldenbourg, Munich. Price, 7 Reichmarks. —To design a cable distribution network for maximum economy requires consideration of many factors, among them the spacing of stations and substations, the magnitude of the loads and the load density, as well as the various elements of cost. The present work discusses these considerations and presents formulas for computing the network which takes them into account.

STEP-BY-STEP MODERNIZATION of a Six-Year-Old Plant

By R. S. FITCH
Mechanical Engineer, The Ballinger Company

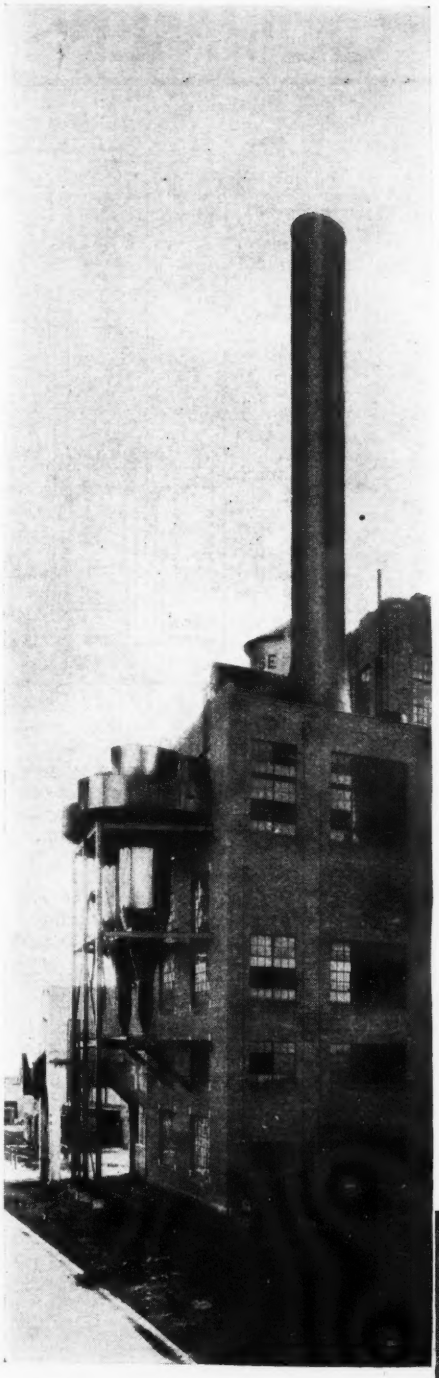
SIX years ago, the Viscose Company installed in its Parkersburg, W. Va., plant a boiler and power plant consisting of four 10,000-sq.ft., cross-drum boilers designed for 275 lb. and 150 deg. superheat and fired by underfeed stokers. Three years later, it was decided to take advantage of $2 cheaper local coal and to modernize the plant. The existing arrangement was not suitable for burning pulverized coal, for boilers would require water walls, furnace bottoms and ash handling equipment had limitations, and the necessary rearrangement of ducts, air heaters and building construction involved estimated expenditures in excess of the cost of new equipment. It was also felt that with such a complicated problem, additional changes would probably be encountered which would increase costs.

One new boiler and pulverizing equipment was installed immediately. A second has just been added, resulting in a 3 per cent increase in efficiency and complete modernization of the plant. The original installation is now used only for standby.

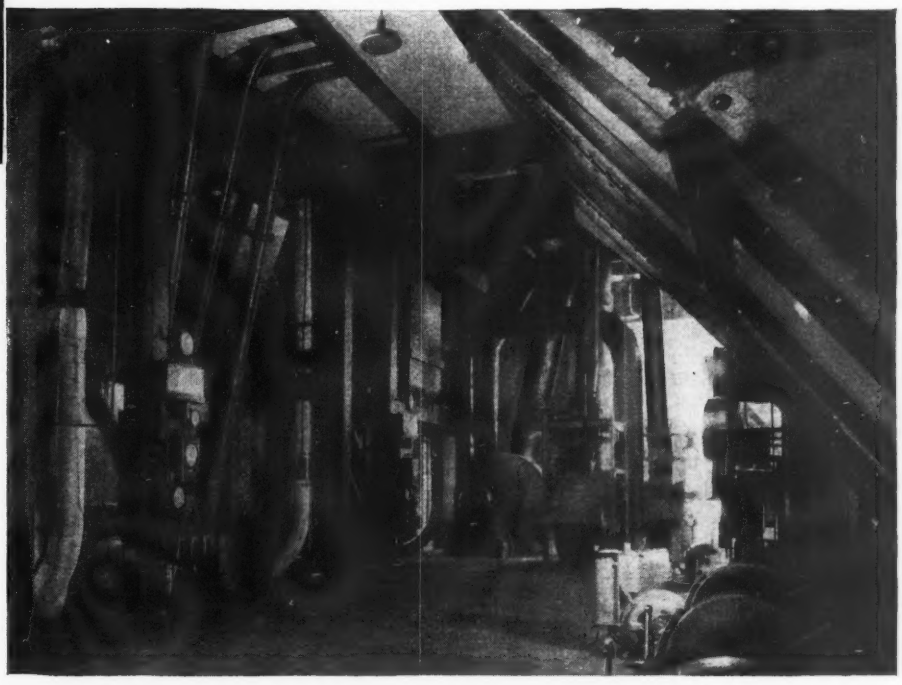
Installation of the pulverized coal ducts and cyclone collector presented a problem in that the space allotted to the original pulverizing plant was utilized for the new apparatus. Ducts and equipment were moved without interfering with operation.

New Equipment—Parkersburg Plant, Viscose Co.

Boilers, two 10,144 sq.ft. sectional header, 275 lb., 175 deg. superheat Walsh & Weidner	Combustion Engrg. Co.
Pulverizing Equipment, Lopulco System, two 15-ton Raymond roller mills and Type R adjustable burners	Combustion Engrg. Co.
Furnace Bottoms; Ash-Handling Equipment, Hydrojet System	Allen Sherman Hoff Co.
Superheaters	Foster Wheeler Corp.
Air Heater and Economizer (first unit)	Foster Wheeler Corp.
Split-Type Air Preheater (12,400 sq.ft. plate area) (second unit)	Combustion Engrg. Co.
Soot Blowers	Diamond Soot Blower Corp.
Forced-draft fan, 40,000 c.f.m. @ 8.3 in. s.p. 1,755 r.p.m.	Buffalo Forge Co.
Induced-draft fan, 65,000 c.f.m. @ 7-in. s.p., 1,142 r.p.m.	Buffalo Forge Co.
Fan Motors, Variable-speed	Crocker Wheeler Co.
Fly Ash Collectors, two No. 60 Type D	American Blower Co.
Coal Scale, Apron-feed type, 400-lb. capacity, hourly capacity 15 to 18 tons	Richardson Scale Co.
Feedwater Regulator, 4-in., Copes	Northern Equipment Co.
CO_2 Meter	Republic Flow Meters Co.
Draft Gage	Ellison Draft Gage Co.
Flow Meter, steam-air type	Bailey Meter Co.
Water Column, inclined-gage type	Yarnall Waring Co.
Magnetic Coal Pulley	Magnetic Mfg. Co.
Air and Gas Ducts	Connery & Co.
Piping	B. F. Shaw Co.
Installation, boilers and pulverizing plant	Viscose Co.
Electrical equipment, fans, scales, building	Combustion Engrg. Co.
Drawings, Specifications and Supervision	The Ballinger Co.



Annoyance from cinders in the vicinity of the Viscose plant has been eliminated by installing two fly-ash collectors on the pulverized-coal burning units. Dust and fly ash are removed before the gases enter the induced-draft fans. Only the new section of the power plant is shown



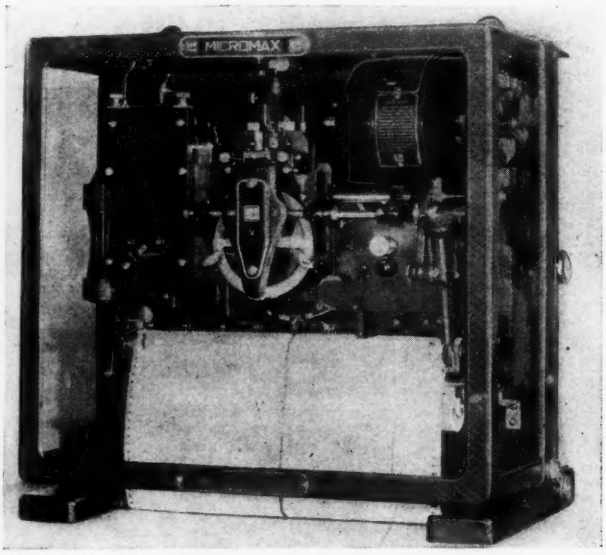
Two modernizations in six years tell the story of continual progress in this plant. The two new boilers are at left and the four original units, now used only for standby, are at right

WHAT'S NEW IN PLANT EQUIPMENT

Frequency and Time-Deviation Recorder

Both system frequency and any difference in time up to 10 sec. between system time and standard-clock time are shown simultaneously on one chart of this new Micromax frequency and time-deviation recorder. In measuring time difference, a synchronous motor in recorder checks system time and is automatically compared at 1-min. intervals with time of regular master clock. Any difference is recorded at right-hand edge of chart. Recording device is simple, and record is legible. In measuring frequency, standard L&N frequency-sensitive impedance bridge is used, as in other L&N frequency recorders. Record of present machine is, however, opener and easier to read. Scale is only two cycles instead of usual four; each chart division therefore represents only 0.02 cycle instead of 0.05 as heretofore.

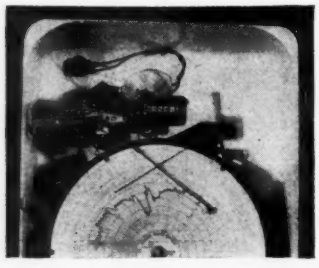
Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.



Escapement-Type Integrator

Total flow in gallons, pounds or other units is given on a six-figure counter incorporated in the new Bailey escapement-type integrator. Heart-shaped cam, with uniform angular rise, is geared to Warren synchronous motor and rotated at 2 r.p.m. By means of friction clutch between cam and escape wheel, motor also drives escape wheel and integrator counter at constant speed when pawl is not engaged. With pawl engaged with escape wheel, integrator counter is held stationary, but friction clutch allows cam to continue rotation. Roller arm is pivoted near its left end to the flow mechanism, so that position of pivot varies only with changes in the rate of flow. Right end of roller arm moves up and down under action of rotating cam, causing pawl-operating pin to move up and down also. It is this operating pin which is responsible for engagement and disengagement of pawl with escape wheel. Integrator total is thus adjusted to prevailing rate of flow four times a minute instead of once a minute, as formerly.

Bailey Meter Co., 1050 Ivanhoe Road, Cleveland, Ohio.



Insulation Tester

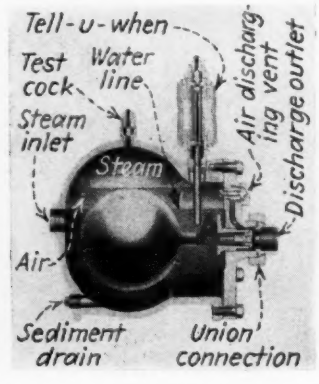
Weighing only 3 lb., and small enough to slip into an overcoat pocket, this "Megger" midget insulation tester is $5\frac{3}{4}$x4x$2\frac{3}{8}$ in., and incorporates a true ohmmeter, direct reading like a voltmeter, and a d.c. hand generator supplying testing current at 500 volts. Scale reads as high as 20 megohms. Special spring plunger-type terminals. No projecting or loose parts. Case molded synthetic resin.

James G. Biddle Co., 1211-13 Arch St., Philadelphia, Pa.

Steam Trap

Model F Swendeman steam trap has three new elements, "Tell-U-When," which indicates at a glance if valve is wire drawn and wasting steam; air vent, which continuously discharges air as it comes into trap and prevents air binding, and union connection, which permits replacing of valve and seat in 3 min. Smallest traps handle 2,600 lb. per hr. at 40-lb. pressure, largest handle 24,000 lb. at 40-lb. pressure. At pressure of 300 lb., largest unit handles 8,400 lb. per hr. Pipe sizes, $\frac{1}{2}$ to 2-in.

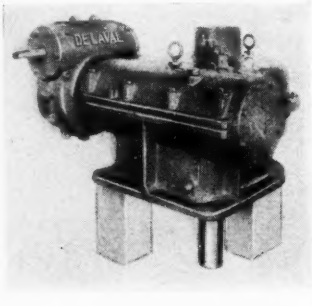
J. E. Swendeman, Inc., 171 Camden St., Boston, Mass.

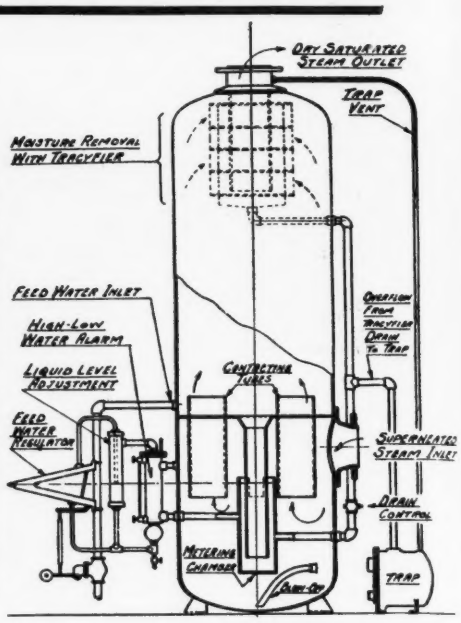


High-Ratio Worm Gear

This double-reduction worm gear gives considerable latitude in respective locations of driving and driven machines. In this design the high-speed gear wheel is mounted on slow-speed worm shafts, but greater flexibility in arrangement of drive has been gained by using separate housings for high-speed gear and slow-speed gear. Gear tooth and worm surfaces and bearings are lubricated by a splash system, high-speed gear wheel and slow-speed worm dipping in oil bath in casing. High-speed worm shaft and shaft carrying high-speed gear wheel and slow-speed worm have ball bearings. Slow-speed shaft has plain sleeve bearings, or, when horizontal, may be fitted with tapered roller bearings.

De Laval Steam Turbine Co., Trenton, N. J.

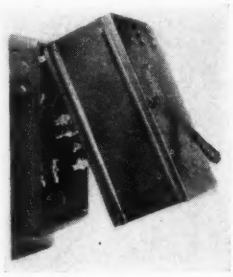




Desuperheater

Based on an entirely new principle which combines in one piece of apparatus complete desuperheating with steam purification. It is essentially an assembly of a Blaw-Knox Contactor combined with Tracyfier (steam purifier) and equipped with a standard make of boiler feed-water regulator. No moving or cloggable parts. Unit is inherently automatic and can be built to the A.S.M.E. code.

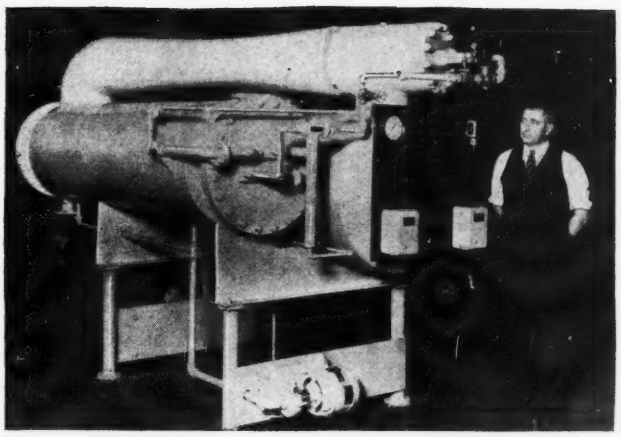
Blaw-Knox Co., Pittsburgh, Pa.



Air Circuit Breaker

This line of manually and electrically operated, trip-free, multi-pole air circuit breakers for control and protection of circuits in all fields is designated as Type AB-2. Attainable in metal-inclosed construction, with or without pull box, metal-inclosed with pull box and disconnecting devices to permit inspection of breaker while it is disconnected, or mounted in dead-front and metal-inclosed switchboards shipped assembled. Ratings range from 15 to 400 amp., 250 volts d.c., and 600 volts a.c. This type has high interrupting capacity.

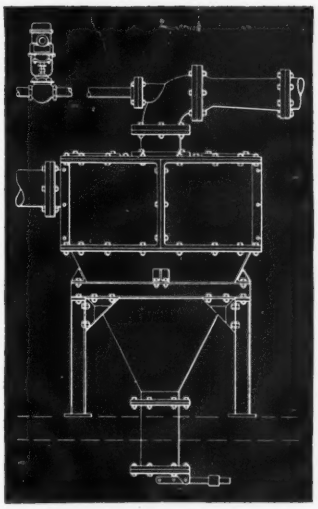
General Electric Co., Schenectady, N. Y.



25-Ton Steam Jet Refrigeration Unit

Suitable for cooling water for air-conditioning, drinking or any industrial process requiring water at any temperature between 35 and 60 deg. F., 25-ton steam jet refrigeration unit illustrated operates on steam pressure of 100 lb. gage and has a refrigeration capacity of 25 tons at 40 deg. F. It can be made to operate on any steam pressure from atmospheric up. Unit is complete and requires no special foundation.

Ross Heater & Mfg. Co., Inc., 1407-1411 *West Ave., Buffalo, N. Y.*



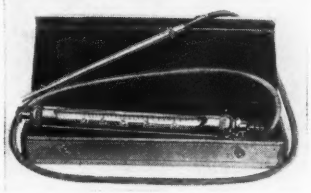
Tankless Suction Conveyor System

Vasco suction ash conveyors may now be had which do not require former air-tight storage tanks. Uses separating receiver illustrated instead for collection of ashes for short period. It is made of hard white iron for ashes and of sheet steel for soot. A time-cycle contactor electrical motor valve is used for intermittent operation. Where steam pressure is insufficient, positive blower can be substituted for steam-operated vacuum producer. System normally consists of tank or ash hopper in which suction is produced and pipe lines to ash or soot intake at each boiler. Exhausting steam in tank causes air inrush which carries ashes or soot into receptacle. Bottom gate permits receptacle to be emptied.

Vacuum Ash & Soot Conveyor Co., Inc., Wilson Ave., Newark, N. J.

Smoke-Tube Draft Gage

Without liquids or moving parts and not requiring leveling, this smoke-tube draft gage also gives static pressure readings in apparatus in ducts and for similar work. Smoke tube is filled with smoke from cigar or cigarette, and tip of flexible tube placed in draft or other air flow

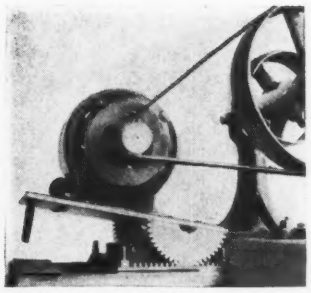


to be measured. Flow of air through tube causes air jet which clears smoke from upper portion of tube for distance dependent on pressure. Smoke level indicates draft on tube surface, calibrated in inches of water.

E. Vernon Hill Co., 121 *N. Clark St., Chicago, Ill.*

Self-Adjusting Motor Base

Motor or generator is supported on a base platform or arms, at one end of which are secured two gear segments of proper size and radius. These mesh with racks provided with lateral guides. Leg at other end of platform keeps unit at reasonable level when belt is not on pulley. When belt is on pulley, swinging action of mechanism allows weight of motor to impart tension to belt, at same time keeping tension uniform and providing take-up for belt stretch. Variable fulcrum at point of contact between gear

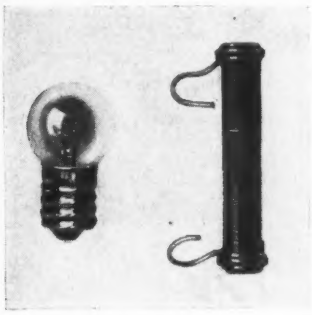


and rack avoids increase in lever arm and therefore increase of belt tension. Since motor and platform are simply laid on racks, motor can be used alternatively on another machine provided with proper racks. Invented by J. L. deRabot, consulting engineer of:

Alexander Bros., Inc., 406 *N. Third St., Philadelphia, Pa.*

Neon Lamp for Signal Indicators

Type N-1 Neon glow lamp for signal indicator service has G-6 bulb and candelabra screw base. No ballast resistance is placed inside base. External resistors similar to those used in radio can be placed in series



with the lamp socket and varied to suit particular application. This permits low list price. Lamp begins to glow at 85 volts and 110 volts d.c. Only one electrode glows on d.c. circuits, making it possible to use lamp as polarity indicator. These lamps are used as indicators on circuit breakers, power-house switchboards, and in tube testers.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Copper Pipe Fittings

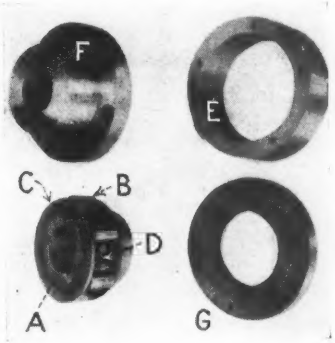
Parker "Innerseal" fittings "make-up" pressure tight with tube without solder, solder being placed in joint between tube and fitting in uniform space provided all around. Seals at both inner and outer ends of joint and has "pockets" in fitting to better bond. Heat-indicating color band on fitting indicates proper soldering temperature. Made of high-copper bronze, heavy enough to withstand

wrench pressure on pads. All types and sizes.

Parker Appliance Co., Cleveland, Ohio.

One-Way Free-Wheeling Clutch

This clutch for use between standby steam turbines connected to induced draft fans, dual drive exciters, as nobacks on incline coal conveyors, dual drive pulverizers and similar uses, is known as "Kelpo" free-wheeling clutch coupling. It consists of drive gear *A*, cam gears *B* mounted in cage *C*, set of springs *D* and case comprised of ring *E*, drive flange *F* and cover *G*. *A* is mounted on prime mover shaft and meshes cam gears *B* mounted in cage *C*, and this assembly is contained in the case so that they engage inner surface of ring *E*. Drive flange *F* is mounted on load shaft and has ring *E* and cover *G* bolted to it to make



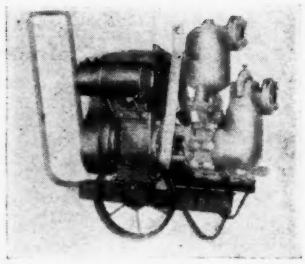
complete case which revolves with load shaft. When cam gear *A* is rotated in the driving direction, it turns cams so that they grip case and drive load. When load shaft rotates faster than prime mover shaft or "free-wheels," cams allow case to slip past them freely. Springs serve only to keep cams in contact with ring *E* ready to grip. Cover *G* is a press fit on ring *E* and is fitted with felt grease seal where drive gear *A* passes through it. Flange *F* is press fit on ring *E* and securely bolted. Unit can be assembled on job to operate in either direction. It can be used both for free-wheeling coupling and for a ratchet.

Kelpo Clutch Co., 216 *Mill St., Rockford, Ill.*

Automatic Clutch

"G-O-B" clutches are adaptable to every class of machinery and are practical integral with driving wheels or when bolted to any type of driving wheel. Driving pawl, which is in contact with angular contact point on bushing (which is keyed to shaft) is held in position by load spring as shown at left. Adjusting screw compresses load spring until pawl remains in this position, which corresponds to the safe load on machine. Any resistance or overload beyond this safe load will release pawl and throw it into a locked position, as shown at right. To reset driving pawl in its engaged position, the body to which driving pawl is fixed is turned until arrow points face each other. Cam is then turned, allowing pawl to drop into its original position. It can be used on underfeed stokers, coal conveyors, etc.

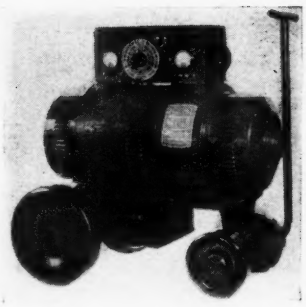
G-O-B Engineering Co., 1953 W. 63rd St., Chicago, Ill.



Portable Pump

La Bour No. 15 WPD and No. 20 WPD has no valves or other priming mechanism and no recirculation or capacity loss after prime has been established. Guaranteed suction lift 20 ft. at sea level. All pump castings electric-furnace cast iron. Single, open-type impeller of alloy steel. Structural steel mountings. Sizes from 2½x2 (160 g.p.m. at 20 ft. suction or 100 at 50 ft.) to No. 40 DHL 6x5 (800 at 20 ft. or 500 at 60 ft.). Engines vary from 3 hp. for smallest to 25 hp.

La Bour Co., Elkhart, Ind.



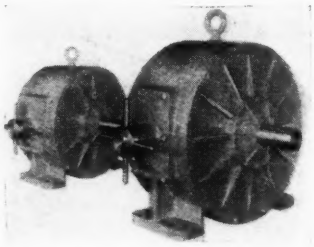
Electric Arc-Welding Equipment

Redesigned Hobart welder has 60 per cent more capacity and is fitted for handling both coated and plain rods. Easy to operate, and new louver construction makes it waterproof. Remote control permits operator to weld 50 to 100 ft. away from machine.

Hobart Bros. Co., Troy, Ohio.

Hydraulic Pumps and Motors

This complete new line of Series 5000 "Northern" hydraulic pumps and motors of the rotary radial-piston type includes units from 1—200 g.p.m. and pressures of 4,000 lb. per sq.in., pumping oil for hydraulic systems. Volume of discharge variable from 0 to maximum capacity and discharge can be reversed without stopping pump or changing speed or rotation. Applications include high-pressure lubrication, variable-speed drives, stokers, and clinker grinders. Available with complete line of automatic controls and semi-automatic valve mechanisms. All have Nitralloy fittings and interchangeable parts. Can be used with automatic controls. Incorporate balanced-pressure design. Sensitive control, automatic speed increase, reduced maintenance, smooth action, high efficiency, flexibility, no fire hazard.

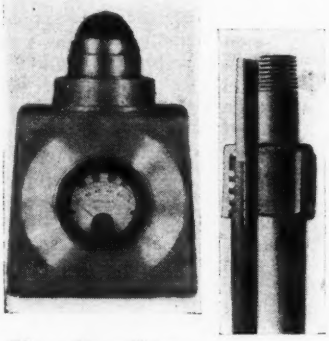


Northern Pump Co., Minneapolis, Minn.

Sensitive-Cell Smoke Detector

Light from projector on one side of smoke passage falls on sensitive cell on opposite side, causing variations in cell electrical output. This current may be read on meter graduated in percentages of light obscuration (having also Ringelmann points indicated) in which case it is called "Smokgage". It may be used to operate a relay for flashing light when permissible density is exceeded (Smoklite) or for ringing bell (Smokbell). Combinations may be had. The Smokgage-Smoklite below calls operator's attention by signal lamp and affords gage for regulating burner to desired density. Smoke values can be recorded on chart or an operation recorder used to keep records of a number of indicators.

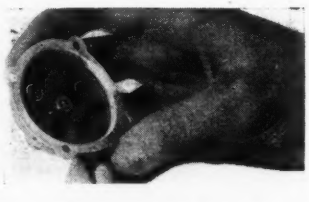
Ess Instrument Co., 816 Agnes St., Parkersburg, W. Va.



Hose Coupling

Wil-Bro couplings and menders utilize "compression collar" instead of clamping in the ordinary sense. Collar has unusual spiraled inner groove applied over a coiled wire. This brings about uniform compression around entire circumference of hose. Permits use of thin-walled insert and results in maximum unrestricted flow allowance. To add insurance against blow-offs, in addition to insert being retained in hose by compression, a flange is provided on clamp end to engage shoulder on coupling insert.

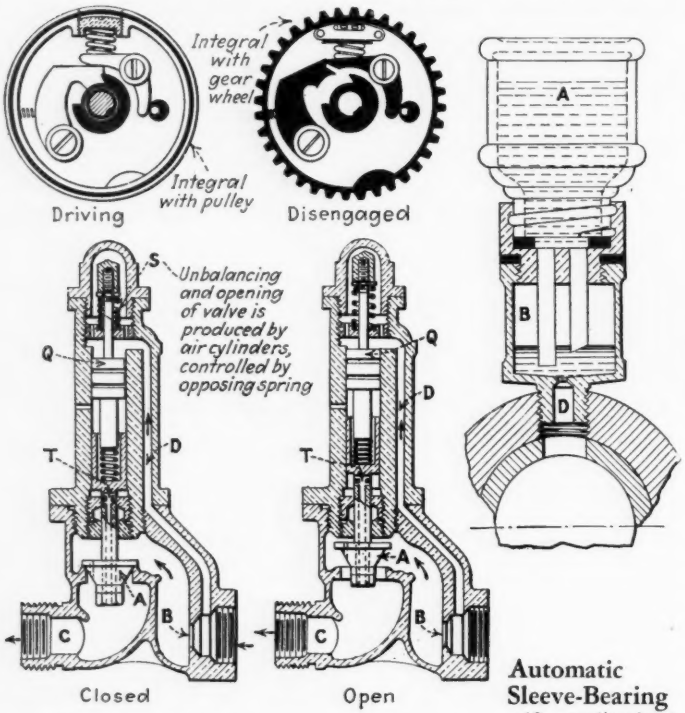
Wil-Bro Corp., 88 Second St., San Francisco, Calif.



Disk Thermostat for Motor Protection

These disk thermostats can be used on small or large motors to open circuit when motor gets too hot, then to close circuit again after motor cools. Will handle up to 15 amp at 110 volts. Also can be used on large motors to operate a protective relay.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.



Automatic Sleeve-Bearing

(Cross-section above)

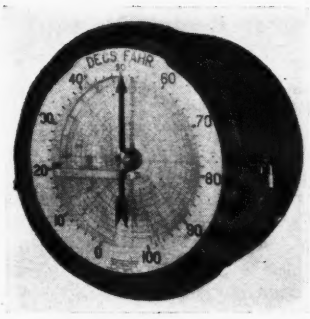
Automatic Air Line Control Valve

This Yarway-Becker automatic control valve provides automatic control of air line when nipple blow-offs or disconnections occur. Normally air passes beyond plunger *A*, valve being held open by air pressure from *C* passing through cored hole in valve stem into opening *T*, which counterbalances pressure in *D* on *Q*. When air pressure at outlet suddenly drops, pressure in *D* builds up and closes plug automatically.

Yarnall-Waring Co., Philadelphia, Pa.

"Speedway" thermal oilers are automatic and operate on temperature changes of 2 deg. Main oil supply is held in glass bottle *A*, from which it flows as needed to thermal chamber *B*. Any slight rise in temperature of bearing is communicated to air imprisoned in *B*, which expands, forcing oil out of small opening *D*. Ratio of air and oil in chamber *B* is constant, insuring uniform operation. Claimed to provide complete lubrication as needed without oil waste.

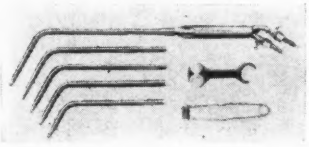
Speedway Mfg. Co., 19th & 52nd Ave., Cicero, Ill.



Round-Chart Indicating Recorders

These single-point Model R "Micromax" recorders are less complete, consequently lower in cost, but embody the principle and elements of the strip-chart Micromax. Units claimed particularly valuable in pyrometers of 400 to 900 or 1,000 deg. F. range, because of long-life temperature detector (replaceable) and possibility of remote indication by recorder. Also adapted to recording temperatures across entire range of thermocouples, of resistance thermometers, to recording of smoke density, liquid levels, SO_2, speed, solar radiation and other applications. Has large-lettered circular scale and uses 24-hour circular chart with straight-line time coordinates instead of curved ones to increase readability. Its calibrated portion is 3½ in. wide, and chart is 10⅜ in. in diameter over-all. Recorder made as single-point instrument only, and can be equipped with two signal or control contacts. Potentiometers manually standardized. Mechanism mounted on frame hinged to case for swinging out if desired. Case 16½ in. diameter, mounted either flush or hanging on face of wall or panel.

Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.



Welding Torch

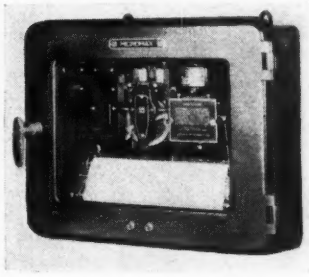
"Purox" No. 28 welding torch has same efficiency and low gas consumption as Purox No. 20 but is different in design to handle heavy-duty work. Ten one-piece, 60-deg., gooseneck tips, numbered from 6 to 15, are available. Adjustment provided so overhead or vertical welding can be done without change in normal grip of torch handle. Tips 6, 8, 10, 12 and 14 furnished with torch.

The company has also announced an improvement in Oxweld Type CM-17 cutting attachment whereby heating oxygen throttle can also be used as an oxygen shut-off valve for use during temporary stops in cutting.

Linde Air Products Co., 30 E. 42nd St., New York, N. Y.

Multi-Purpose Case for Recorder

Dust-tight, and vapor-tight when desired, this multi-purpose case can be supplied for mounting in any position—flush in panel, on front of panel or wall, or on table or bench. It is sealed by turning handle, thus



pressing door tightly against rubber gasket. Lock is outside gasket, hence vapors cannot filter into case through it. Switches for motor, lights and control circuit are operable externally and vapor-proof. Leads to recorder are brought in through conduit connections or a pothead. Mechanism can be swung completely out of case so that it is accessible from all sides. Adapted to all types of control, remote, recording, etc.

Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.

Pipe-Ventilated Motor

Designed for unusually severe service exposed to excessive humidity, high temperature, abrasive particles, heavy dust and corrosive fumes, this pipe-ventilated motor is a totally inclosed, polyphase, squirrel-cage induction motor. Ventilation is supplied by large centrifugal fan, drawing air from any handy source and discharging into room or to exterior outlet. Vent pipes connected to vent stacks shown. Supplied to meet all torque and inrush classifications for both squirrel-cage and slip-ring induction motors, 1 to 200 hp., including across-the-line start motors. Unity and leading power factor induction motors also furnished. Motors for two- or three-phase, 25, 30, 50 or 60 cycle-current, and up to 2,300 volts. Also, two-, three- or four-speed.

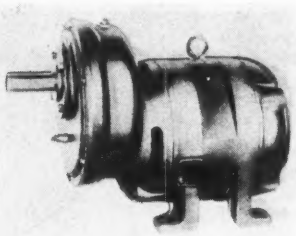
Ideal Electric & Mfg. Co., Mansfield, Ohio.

Diaphragm Valve

(Right)

TAG friction-free diaphragm valve is designed to reduce friction to the minimum. Improved super-structure is mounted on TAG V-port balanced valves, giving gradual opening characteristics. Friction is cut to minimum by reducing diameter of spindle passing through stuffing box. Spindle is guided by its upper (large-diameter) portion which passes through two roller bearing assemblies. The spring (single or multiple) is inclosed, as is also the diaphragm. Positive indicator furnished. Adjustments made easily.

C. J. Tagliabue Mfg. Co., Park and Nostrand Aves., Brooklyn, N. Y.



Motorized Speed Reducer

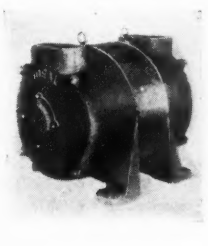
These speed reducer and motor combinations from ½ to 20 hp., and in a wide range of ratios and speeds, have continuous-tooth herringbone gears mounted on anti-friction bearings, running in a bath of oil.

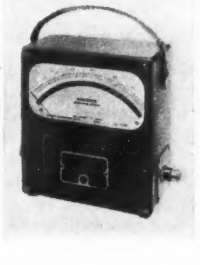
D. O. James Mfg. Co., 1114 W. Monroe St., Chicago, Ill.

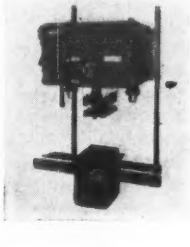
Portable Instruments

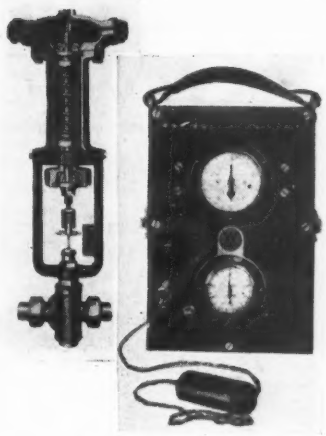
Roller-Smith "Steel-Six" d.c. and a.c. portable instruments, Types HTD and HTA, have steel cases about 6 in. sq. Unusually long scales (5$\frac{3}{16}$ in.) high accuracy, open and lighted dials, fusing when desired. Available in complete line, comprising d.c. ammeters, milliammeters, voltmeters, millivoltmeters and voltammeters and a.c. ammeters, milliammeters, voltmeters, single and polyphase wattmeters, frequency meters and power factor meters. Type HTD for direct current and HTA for alternating current. Accuracy is ½ of 1 per cent of full scale for ammeters, voltmeters and single-phase wattmeters, and 1 per cent of full scale for other instruments.

Roller-Smith Co., 233 Broadway, New York, N. Y.









Portable Stroboscopic Meter Standard

This new standard can be used whether meter does or does not have provisions for stroboscopic testing, and whether meter is to be calibrated or tested to determine its "as found" accuracy. It introduces direct readings of "as found" accuracy and calibration, eliminates "cut-and-try" methods, calculations, stop watches, etc., and cuts over-all testing time. Case divided into two compartments, one containing meter complete and other containing power unit and amplifier.

Westinghouse Electric & Mfg. Co., Newark, N. J.

High-Temperature Brick

"Alumino Hi-Temp" block and brick, low in heat conductivity and capable of resisting temperatures up to 1,900 deg. F., are made of monohydrated bauxite, and have low density and high insulating value. Bonded with asbestos and refractory material. Density, blocks about 26 lb. per cu.ft., brick 28 lb. Thicknesses up to 4 in.; half blocks 9x18, double bricks 4½x18x2½. Also in cement form.

Philip Carey Co., Lockland, Cincinnati, Ohio.

Submersible Combination Breaker and Switch

A combination oil circuit breaker and group-operated disconnecting switch, inclosed in a submersible housing, is designed for mounting on walls of underground vaults. Both circuit breaker and disconnecting switch have manual operating levers so interlocked that switch cannot be operated when breaker is closed, nor can breaker be closed when switch is open. Both levers are on outside of case, with operating shaft passing through packing. Breaker can be equipped for electrical operation. Ratings up to and including 15,000 volts, 2,000 amp.

General Electric Co., Schenectady, N. Y.

POWER LINES

Total Electricity Production Shows 1932 Decline

Preliminary figures of the total production of electricity for public use in the United States in 1932 indicate an output of 82,938,000,000 kw.-hr., a decrease of nearly 10 per cent from the output for 1931. Percentage decreases in the last three years are: 1.5 in 1930, 4.4 in 1931, and 9.6 in 1932.

Total production of electricity for public use in 1932 was about 15 per cent less than in 1929. The decrease in gross revenue from sales of electricity for the same period, according to the *Electrical World*, was less than half this percentage. Production of electricity by water power in 1932 was about 11 per cent greater than in 1931 and 41 per cent of the total annual production. In 1931 the output by water power was only 33 per cent of the total. This increase apparently indicates the end of the drought conditions which affected portions of the United States with more or less intensity during 1929 to 1931.

Increase in efficiency in the use of fuels in generating electricity which has been accomplished each year continued in 1932, even under unfavorable load conditions and decreasing fuel costs. In 1932 the average consumption of coal and the coal equivalents of oil and gas in generating 1 kw.-hr. of electricity was 1.5 lb.—0.05 lb. or 0.8 oz. less than in 1931. This apparently insignificant saving in fuel amounted to conservation of more than a million tons of coal during last year. A complete report, including tables and similar information is available from the Geological Survey, Washington, D. C. The final report which will give total output for each state for 1932 will be published in April.

The total amount of electricity produced for public use in the United States in 1931 was 91,729,000,000 kw.-hr. Of this amount 67 per cent was produced by the use of fuels and the remainder by the use of water power. The amount produced by fuels was 61,124,000,000 kw.-hr., and the fuel consumed in generating this amount of electricity was: Coal, 38,717,000 tons; fuel oil, 8,114,000 barrels; gas, 139,350,000,000 cu.ft., and wood equivalent to about 270,000 tons of coal.

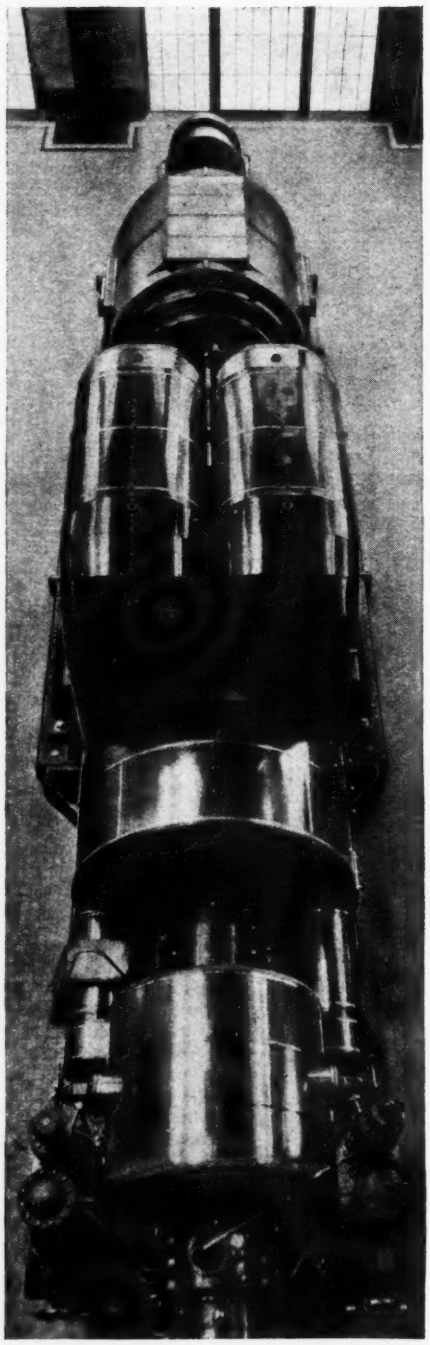
Power Engineers to Participate in Engineering Week

Plans for the huge conference of engineers during Engineering Week, June 25-30, of the Century of Progress Exposition are making progress. Power engineers will be particularly active during the week at sessions of the A.S.M.E. at the Palmer House and at the exhibits of the World's Fair and the Power Show at the Coliseum.

Preliminary plans for the national meeting of the A.S.M.E. call for sessions on fuels and various phases of central station and industrial power plant practice. In addition to the meetings of the A.S.M.E., some twenty of the national engineering societies will participate with sectional and national meetings.

Since most of the exhibits at the Century of Progress Exposition will be of a broad educational character the Midwestern Engineering and Power Exposition becomes an important part of activities of Engineering Week. At this Chicago Power Show engineering developments will be interpreted in terms of individual manufacturers products. Some 300 companies will show their latest equipment for the efficient production and utilization of power.

The combined membership of the engineering groups participating in Engineering Week is 91,600.



One of four 55,000-kw., 3-cyl., 1,500-r.p.m. turbines in Vitry-Sud Station, Paris. Steam conditions at boiler are 840 deg. F. and 550 lb.

Elaborate Investigation Finished on Steam Thermal Properties

The most elaborate and complete investigation into thermal properties of steam ever attempted is nearing a close after 12 years of research work, according to the 1932 volume of Research Reports & Papers recently published by the A.S.M.E. Data already obtained is aiding in the design of equipment for use of steam at high pressures and temperatures. This investigation is part of an international search for knowledge of properties of steam. The experiment program has been conducted at the National Bureau of Standards, Harvard University, and M.I.T. under direction of a research committee of the Society, headed by Alex Dow, president of Detroit Edison Co. Since the beginning of the work in 1921, industry has subscribed approximately $160,000 to the cooperative study. During the past three years international conferences have been held in London and Berlin by various investigators and skeleton steam tables have been formulated with sufficient tolerances to include all the well-substantiated data. Work is now in process to narrow down the tolerances and a third conference on the subject is planned in the United States this fall.

Smoke Pollution Control Requires Districting

The next logical development in the increasingly successful fight on atmospheric pollution must be the creation of air hygiene districts which will cover and control metropolitan smoke areas, according to H. B. Meller, head of the Air Pollution Investigation, Mellon Institute of Industrial Research, and chief of the Pittsburgh Bureau of Smoke Regulation. "In defining the boundaries of air hygiene districts for the nation's great industrial centers," said Meller, "county and even state lines will have to be disregarded. People must view these smoke areas as the airman sees them, great mushrooms of atmospheric filth from 30 to 60 miles in diameter. Control can be effective only when all the smoke-producing sources of a manufacturing district are brought under uniform regulation."

He said further: "All new equipment could be required to meet regulations, and the same rule could apply to alterations and repairs. A reasonable time could be allowed for compliance by plants already installed without restriction. Such a program would not be difficult to follow through. Experience has developed that plant owners cooperate willingly, once they are shown the harm being done and the money being wasted by smoky plants. Under such a program, the private home could no longer be exempt from regulation."

Niagara Power Conference At Time of N.A.P.E. Meeting

The Niagara Frontier Power Conference & Mechanical Exposition is scheduled for the Buffalo (New York) Auditorium, Aug. 28 to Sept. 2, together with the National Convention of the National Association of Power Engineers. The exposition will be held in the Broadway Auditorium, which provides the necessary facilities in its 47,000 sq.ft. of main floor space and adjacent meeting rooms. Booth space is now for sale from the National Exhibitor's Association, John H. Allen, president, Everlasting Valve Co., One Montgomery St., Jersey City, N. J.

Included in the organizations sponsoring the exhibit are the Engineering Society of Buffalo, A.S.M.E., A.I.E.E., I.E.S., A.S.C.E., A.W.S., A.S.H.V.E., N.A.P.E., and the State N.A.P.E.

Gas-Fired Boiler Blows Up

The gas-fired boiler furnace in the municipal electric plant of Colorado Springs blew up Jan. 31, killing John N. A. West, boiler expert, and seriously injuring chief engineer J. J. Monaghan, fireman W. H. Salisbury and Charles Martin, a worker on the boiler. The first test was made Jan. 30 and everything showed O.K., but when the gas was ignited on the following morning there was a loud report and casings were thrown out. It is believed that in some way the gas pipe was leaking. A large quantity of gas accumulated, and as soon as the flame approached an explosion resulted. The new unit cost $240,000, and it is believed that it can be repaired at nominal cost, since there was no fire following the explosion. Reserve machinery will carry the load for the present.

Wrought Pipe Standard Proposed

The American Society of Mechanical Engineers has issued to those interested a set of proofs on the proposed American Tentative Standard on Wrought Iron and Wrought Steel Pipe sponsored by the A.S.T.M. and A.S.M.E. After suitable review and criticism, it is to be made into the American Standards.

A new American Standard for shaft couplings, integrally forged flange type for hydro-electric units (B49-1932) has been approved by the American Standards Association. The standard includes tables relating to the coupling dimensions, and to the drilling layout and bolt dimensions, respectively. The standard was developed by the A.S.M.E. committee on Standardization of Shaft Couplings.

Air Conditioning Interest Shown on Both Coasts

Two reports showing wide interest in air conditioning problems have been received. A western conference on the subject was held in San Francisco Feb. 9 and 10, sponsored by the A.S.M.E. and the University of California. Attendance of well over 200 was reported. The second report comes from Rutgers University, which has enrolled in its home study course in air conditioning representatives of more than 20 states and Canada. Those taking the course include utility presidents, college professors, engineers, technical consultants, superintendents, technical men, and commercial leaders.

Welding Course Offered in Cleveland

John Huntington Polytechnic Institute, Cleveland, in cooperation with Lincoln Electric Co., will offer another course in "Designing for Welded Construction," beginning April 3. The course consists of a week of intensive work, six days being spent in the welding school of Lincoln Electric Co. Each evening a lecture on designing for arc-welded construction is given at the Institute. Enrollment for the course is limited to 30 men.

Institute of Metals Holds 25th Annual Meeting

Included in papers to be presented at the 25th annual general meeting of the Institute of Metals, March 8 and 9, at the Institution of Mechanical Engineers in London are: "The Fatigue-Resisting Properties of Light Aluminum Alloys at Elevated Temperatures," by J. W. Cuthbertson; "The Electrical Conductivity of Aluminum Wire" by A. J. Field and J. H. Dickin; "An X-Ray Investigation of the Copper-Aluminum Alloys" by A. J. Bradley and Phyllis Jones. The second afternoon will be devoted to a visit to the headquarters of the British Non-Ferrous Metals Research Association.

COMING MEETINGS

Sixth Midwest Engineering & Power Exposition — Coliseum, Chicago, Ill., during "Engineering Week," June 25-30, of the Century of Progress Exposition. Headquarters, 308 W. Washington St., Chicago, Ill.

American Society for Testing Materials—Annual Meeting, The Stevens, Chicago, Ill., June 26-30. C. L. Warwick, Sec.-Treas., 1315 Spruce St., Philadelphia, Pa.

Leipzig Trade Fair—March 5-12, Leipzig, Germany. Information from Leipzig Trade Fair, Inc., 10 East 40th St., New York, N. Y.

Nat'l Ass'n. Power Engineers—National Convention, in conjunction with Niagara Frontier Power Conference & Mechanical Exposition, Buffalo, N. Y., Auditorium, Aug. 28—Sept. 2. Fred W. Raven, Secretary, 1140 Lake St., ak Park, Ill.

American Welding Society—Annual Meeting, Engineering Societies Building, 29 West 39th St., New York, April 27-28. M. M. Kelly, Secretary, above address.

Canadian Electrical Ass'n. — 43rd Annual Convention, June 14-16, Log Chateau, Lucerne-in-Quebec, Canada.

Institute of Metals — 25th Annual General Meeting, March 8-9 at the Institution of Mech. Engrs., London, S.W. 1. G. Shaw Scott, Secretary, 36 Victoria St., Westminster, London, S.W.1, England.

Fourth Annual Greater New York Safety Conference — Pennsylvania Hotel, New York City, March 1-2.

Second American Exposition of Brewing Machinery, Materials & Products—Auditorium Hotel, Chicago, Ill., Sept. 23—Oct. 1, together with meeting of Master Brewers Ass'n of America. James R. Nicholson, 55 West 42nd St., New York, N. Y., secretary. Felix Mendelsohn, managing director of exhibit.

Unemployed Engineers Should Examine Local Agencies

Judging from the correspondence received at Engineers' Relief Headquarters, apparently many unemployed engineers throughout the United States are unaware that various forms of relief are available in their own communities. Practically every state, county, and city has raised or appropriated funds to provide for the relief of the unemployed. These funds are being expended in various ways.

Experience during the past months indicates that all engineers out of work and in need of assistance should first acquaint themselves with the local method of providing relief. This may be done by getting in touch with any of the following persons in their community: (1) officers of local sections of national engineering societies, (2) officers of local engineering clubs, (3) the City Engineer, or (4) the County Engineer. If the engineer is so located as to be unable to reach any of the persons mentioned, a letter to the Secretary of any national engineering society will bring suggestions as to what seems to be the next best procedure.

Crane Builders Refuse Detail Drawings

The Locomotive Crane Manufacturers Association has decided by resolution to stop giving detail drawings of standard equipment to users of cranes in order to avoid the additional engineering expense and possibilities of danger from faulty repair. The statement says in part: "Working drawings are a vital part of a manufacturer's stock in trade and usually represent a costly engineering skill and technical knowledge. They are, in many cases, the result of years of research and experiment absolutely dependent upon a heavy capital investment in plant and equipment. If a charge were made for working drawings commensurate with their actual cost, the purchaser would rarely consider their acquisition."

Mechanical Drive Study

A series of 50 weekly reports entitled "Mechanical Power Transmission from Motor Drive to Industry" by Robert W. Drake, electrical engineer, has been prepared by the American Leather Belting Association, 41 Park Row, New York, N. Y. Reports cover the transmission of mechanical power from electric motor to driven load by belting and by other means. Reports are written for millwrights, maintenance men, etc., and will be sold in a subscription limited edition. Monthly school type meetings are also being held with Mr. Drake in New York, Chicago, Boston and Philadelphia, and meetings in other cities are planned.

Soviet Diesels

Diesel production in pre-war Russia reached its peak in 1913—a total of 35,000 hp., and oil-burning engines, 65,000 hp. From then until 1921 production ceased almost entirely. Since 1927 a steady increase has occurred. The plan for 1932 provided for 450,000 hp. of diesels and 200,000 hp. of oil-burning engines.

OBITUARIES

CHARLES VALENTINE BARRINGTON, 71, vice-president of Jenkins Valve Co., Bridgeport, Conn., in charge of manufacturing operations, died Jan. 31 at his home at Black Rock.

WILLIAM H. BLOOD, JR., 66, vice-president of Stone & Webster Corp., with which he had been associated for 39 years, died suddenly Feb. 13 in Boston.

JAMES H. JOWETT, 58, executive vice-president of Ingersoll-Rand Co., 11 Broadway, New York, N. Y., died recently.

JOHN E. LYNCH, 82, treasurer of the Hodge Boiler Works, East Boston, Mass., died at his winter home in Florida Feb. 16. He had been connected with the company for 60 years.

CHARLES E. PATTERSON, former vice-president of the General Electric Co. and president of the General Electric Supply Corp., who retired a few years ago, died at St. Petersburg, Fla., Feb. 12, after an illness of several months.

NORMAN L. SNOW, president of the Diamond Power Specialty Corp., Detroit, and Diamond Specialty, Ltd., Windsor, Ont., died Jan. 27.

PERSONALS

JAMES F. FOGARTY has been elected president of North American Edison Co., principal subsidiary of The North American Co., to succeed Edwin Gruhl, who died Jan. 22. FRANK L. DAME has been elected president of North American Co. to fill the vacancy caused by Mr. Gruhl's death.

R. I. BROWN, formerly manager of the Little Rock division, Arkansas Power & Light Co., has become vice-president and general manager of the Mississippi Power & Light Co., with headquarters at Jackson.

C. H. CHAMPLAIN has been appointed general works manager of the Westinghouse Electric & Mfg. Co., according to announcement by J. S. Tritle, vice-president and general manager. He started with Westinghouse in 1898 as machinist and has held almost all positions on his way up to his present one. At the same time, T. I. PHILLIPS was appointed works manager of the East Pittsburgh Works. He was formerly manager of the Nuttall plant and will retain supervisory control of that plant as well.

NELSON E. CHANCE, formerly district manager of the Houston office of Brown Instrument Co., Philadelphia, Pa., has been appointed assistant sales manager with headquarters at Philadelphia.

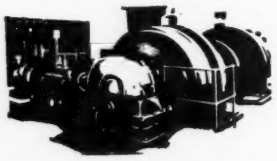
HAROLD V. COES, manager of the Industrial Department, Ford, Bacon & Davis, New York, N. Y., has been elected president for 1933 of United Engineering Trustees, Inc., joint agency of the four Founder Engineering Societies. He succeeds Harry A. Kidder, superintendent of motive power of Interborough Rapid Transit Co.

RAYMOND L. COLLIER, for a number of years assistant managing director of the Steel Founders' Society has been appointed managing director to succeed Granville P. Rogers. Headquarters remain in the Graybar Bldg., 420 Lexington Ave., New York, N. Y.

EDWARD P. CONNELL, who has been with Falk Corp., Milwaukee, since 1913, has just been appointed a vice-president. He is also comptroller.

M. J. CZARNIECKI, formerly manager of tubular sales of A. M. Byers Co., has been appointed general manager of sales. For many years the company manufactured principally wrought iron tubular goods but has more recently broadened its wrought iron products to include plates, sheets, structurals, rivets, forging iron and welding fittings, etc.

F. C. EIBELL, for the past four years manager of advertising and publicity department, Worthington Pump & Machinery Corp., New York, N. Y., has resigned.



JOHN B. FOLEY, JR., 510 Hills Bldg., Syracuse, N. Y., has been appointed Syracuse district sales representative for the Power Plant Equipment division, Swartwout Co., 18511 Euclid Ave., Cleveland, Ohio.

GEORGE W. FULLER, consulting engineer of Fuller & McClintock, New York, has been elected chairman of the Engineering Foundation to succeed H. Hobart Porter. Mr. Fuller is a nationally known hydraulic and sanitary engineer.

GEORGE MYERS, St. Louis Mart Bldg., 12th & Spruce Sts., St. Louis, Mo., has been appointed distributor in the St. Louis territory by Buckeye Blower Co., Columbus, Ohio.

NELSON B. GARDEN has been engaged as a member of H. O. Swoboda, Inc., 3530 Forbes St., Oakland Station, Pittsburgh.

WILLIAM J. O'MEARA has been appointed engineer of the Baltimore office of the General Electric Co. He has been with the company since 1919.

A. M. SNODGRASS has been appointed production manager of the Pittsfield, Mass., works of the General Electric Co. He has been with the company for 20 years.

CHARLES J. THOMSON, construction foreman of the General Electric Co., who supervised erection of huge waterwheel generators on the Dneprostroy hydro-electric project, DR. SANFORD A. MOSS, who designed and introduced the centrifugal supercharger, and HEBERT D. BROWN, who developed the mercury arc rectifier, are among the men who this year received citations from the Charles A. Coffin Foundation.

O. B. WILSON, formerly manager of the Cleveland, Ohio, office of Brown Instrument Co., Philadelphia, has been appointed district manager of the territory including Texas, Lousiana and Southern Arkansas, with headquarters at Houston, Tex.

JOHN B. WHITEHEAD, dean of the school of engineering, Johns Hopkins University, Baltimore, has received the nomination for the presidency of the American Institute of Electrical Engineers, to take office in August, 1933.

BUSINESS NOTES

ASHTON VALVE Co., Cambridge, Mass., has appointed Maintenance Engineering Corp., 1400 Conti St., Houston, Tex., as sales agent in Southeastern Texas.

BABCOCK & WILCOX TUBE Co., Beaver Falls, Pa., has opened a district office in Tulsa, Okla., at 2002 Philtower Bldg., under direction of Carl J. Hochenauer, formerly general manager of Interstate Pipe Co., Pittsburgh, Pa., and manager of the Steel Coupling Division, A. O. Smith Corp.

BRISTOL Co., Waterbury, Conn., has established a British factory at London, England, under the name of Bristol's Instrument Co., Ltd., at 144 Pomeroy St., New Cross, London.

BUCKEYE BLOWER Co. has appointed Sheffler-Gross Co., with offices in the Drexel Bldg., Philadelphia, Pa., as exclusive distributor in that territory.

CONSOLIDATED STEEL CORP., LTD., Los Angeles, Calif., has moved its San Francisco office to Russ Bldg., 235 Montgomery St. This company represents Foster Wheeler on the Pacific Coast.

DAVIS COAL & COKE Co., Baltimore, Md., has appointed E. H. Nicoll sales agent in charge of its Philadelphia office in the Land Title Bldg. He has been with the company for the past four years and succeeds N. W. Garrett.

DELL HYDRO-POWER CORP., Buffalo, N. Y., installing engines, power plants, etc., has been chartered at Albany with a capital of 20,000 shares preferred stock at $10 and 5,100 common non-preferred at $355.

FRANK M. ESCH, P. O. Box 742, Houston, Tex., has been appointed direct representative in Texas for Poole Foundry & Machine Co., Woodberry, Baltimore, Md. ROCKFIELD-DAVIS EQUIPMENT Co., 1500 17th St., Denver, Colo., has been appointed Poole representative in Colorado, Wyoming, and New Mexico.

FISHER GOVERNOR Co., Marshalltown, Iowa, has opened a direct factory sales and engineering office at 30 Church St., New York, N. Y., in charge of O. M. Galiher and with A. W. Bailey and J. J. Belger in the office.

D. W. HAERING & Co., water consultants, have consolidated their general offices, laboratories and consulting offices at 3408 W. Monroe St., Chicago, Ill.

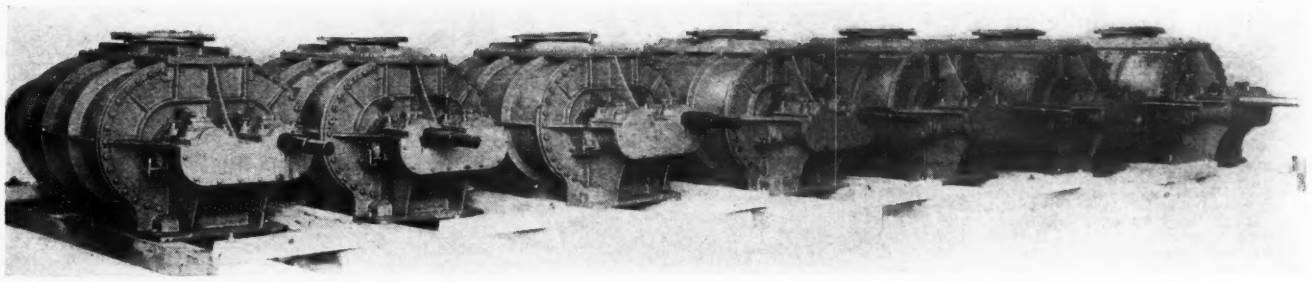
LAWRENCE PUMP & ENGINE Co., Lawrence, Mass., has opened a St. Louis office in the Mart Bldg., at 12th & Spence Sts., under supervision of George Myers.

LOUIS T. KLAUDER & ENGINEERING ASSOCIATES have moved their Philadelphia offices to the Lincoln-Liberty Bldg., N. E. Cor. Broad and Chestnut Sts.

LUCIAN Q. MOFFITT, INC., Peoples Bank Bldg., Akron, Ohio, has been appointed exclusive distributor of Goodrich cutless rubber bearings in the United States and Canada.

NATIONAL WOOD PIPE Co., a new organization, has acquired the property of Standard Wood Pipe Co., at Williamsport, Pa., and will manufacture and sell a full line of wood pipe.

PHILADELPHIA RUST-PROOF Co. has moved its plant to 3229 Frankford Ave., Philadelphia.



These seven large gas pumps of the rotary positive type have been shipped to plants of Liquid Carbonic Corp. at Boston, Mass., Norfolk, Va., Buffalo, N. Y., Philadelphia, Pa., Atlanta, Ga., and Dallas, Tex., by Roots-Connersville-Wilbraham. Pumps have 16-in. gear centers with 42 in. long cases. They are designed to operate at normal speed of 260 r.p.m., and have capacity of 3,500 cu.ft. per min. All have bearings of the renewable ring-oiling babbitted split-sleeve type. The company has also placed an order for a 20x24 in. R-C-W heavy-duty special chemical gas pump for its new plant on Long Island. Purifying equipment will require a differential of from 6 to 6½ lb.

STRAWS

Pointing the way the business wind blows

An average of 4,600 men will be employed for 2½ years in building a transmission line from Boulder Canyon project to the Los Angeles municipal power and light system as a result of an agreement by Reconstruction Finance Corporation to lend $22,800,000 to the department of water and power of the City of Los Angeles. The project embraces construction of a double-circuit transmission line from Boulder Canyon to Los Angeles, approximately 271 miles (see map in Feb. *Power*), having a capacity to transmit approximately 215,000 kw. of electric power at 275,000 volts, the highest transmission voltage in the United States.

Bids for the cylinder gates and entrance liners for the intake towers at Hoover Dam, specification 541, have been received for entrance liners, bulwark head, sills, bolts and screws complete. The low bid is by Goslin Birmingham Mfg. Co., at $56,000, with Marion Machine Foundry & Supply Co., second low with $74,120. On upper and lower cylinder gates, nose liners, throat liners, gate seats and other appurtenances, Westinghouse is low with $334,737, and Allis-Chalmers Mfg. Co., second low with $369,000. There were two combination bids. Westinghouse was low with $412,316, and Allis-Chalmers second with $449,000. No foreign firm submitted prices, even though it had been anticipated that foreign manufacturers would underbid American firms.

Aberdeen, S. D., plans a new call for bids for electric generators, diesel engines, switchboard and instruments and complete accessory equipment for electric distribution and city lighting systems. Estimated cost $850,000.

The city of Seattle's light and power system was operated at a net profit of $435,894.78 during 1932, which was only $69,435.99 less than 1931 profit.

Virginia Electric & Power Co. plans to spend $7,000,000 during the coming year including $1,000,000 for improvements and extensions to power plants.

One large valve manufacturer reports a January gain of 26 per cent in orders booked and 28 per cent in shipments over December, 1932, based largely on small orders, including plenty of repair and renewal parts. One order was for $4,110 for flat glass gages for the Navy Dept.

Surveys and plans have been authorized by Genoa-Columbus Loup River Development Commission, Columbus, Neb., for a hydro-electric generating plant in connection with the power canal from Loup River, to cost about $2,500,000.

Pennsylvania Water & Power Co. earned $4.93 per share in 1932 after all charges, including renewals and replacements and maintenance. This compares with $4.78 in 1931. Gross revenue was $5,240,708 in 1932 as against $5,064,070 in 1931.

The town council of Luray, Va., through the mayor, is planning with Fairbanks-Morse Co. a $100,000 electric and power plant to be owned by the town. Distribution lines would be put up by the town and the plant would be erected by the company. Net profits for five years or longer would be paid to the company. The franchise of Page Power Co. expires July 1, 1934.

The Danville, Va., city council is planning the abandonment of a steam, city-owned electric plant and the development of a large hydro-electric station at the Pinnacles, in Patrick county, Va., at a cost of $2,500,000. Next year the city must either spend $1,000,000 on its steam plant, which is experiencing condensing water difficulties, or carry out the development in Patrick county which was originally surveyed by Tri-Cities Corp., New York, by building three dams and impounding water sufficient to provide electrical energy for Danville, Martinsville, Bassett, Stuart, and the countryside. An R.F.C. loan will be sought.

The Bone power bill was passed by the Washington Senate Feb. 14. The bill authorizes cities operating power plants to extend their distribution outside their municipal borders. In any city or town to which lines shall be extended a vote must first be taken on the issue.

Paragould, Ark., is planning a city-owned electric light and power plant and has authorized a $100,000 fund.

Electric Machinery Mfg. Co., Minneapolis, Minn., will furnish six large high-torque, part-winding synchronous motors for electrification of Northwestern Consolidated Milling Co. flour mills at Minneapolis. These motors replace steam turbine drive formerly used and are direct connected to the mill line shafts. Lockwood Greene Engineers, Inc., are engineering the electrification.

Appalachian Electric Power Co., Roanoke, Va., has concluded negotiations with the Chesapeake & Ohio Railroad for the purchase of power dam of the latter near Lynchburg, Va., and proposes to use the site for a new hydro-electric generating station. The initial plant will be equipped for a capacity of about 5,500 hp., and will be tied in by a new transmission line with the company's present station at Reusens, Va. A large water storage reservoir used for the last noted development will be utilized as well for the power project at Lynchburg, assuring reserve water supply. The project is reported to cost close to $550,000, and work will be put under way as soon as the details of contract with the railroad have been consummated. Company engineering department will be in charge.

An exact model of the Hoover Dam and power plant, the biggest thing of its kind ever built by man, will be built for the Chicago Century of Progress Exposition next summer. The Bureau of Reclamation, of the Department of the Interior, is planning the project.

A municipal ownership plan in somewhat new form has appeared in the Northwest in proposals by the Utilities Co., Inc., San Francisco. This is a consulting engineering and underwriting firm with an apparent connection with Atlas Imperial Diesel Engine Co., and is headed by Leon B. Jones, president. Its proposal, formally presented to five towns in Oregon and Washington, uniformly offers to finance the installation of an Atlas Imperial diesel-engine plant and the acquisition of existing distributing system, the whole to be paid for out of earnings and completely amortized in 11 to 14 years.

New Bulletins

CONVEYOR BELTS—A four-page insert for its mechanical goods catalog on its "Maxecon" general service conveyor belt and improved hot material belt has been published by B. F. Goodrich Rubber Co., Akron, Ohio. The insert discusses construction and typical applications of the two types of belting.

CONNVEYOR-ELEVATORS — Stephens-Adamson Mfg. Co., Aurora, Ill., has issued two folders describing the Redler conveyor which carries materials through inclosed steel casings, horizontally, vertically, up inclines and even around curves.

COAL NEWS—Davis Coal & Coke Co., Continental Bldg., Baltimore, Md., has just issued the first number of Davis Coal News, a 16-page publication which will be distributed monthly in the interest of improved coal burning practice. It will be distributed to engineers and executives interested in economy and reliability in steam operation.

FURNACE WALL BLOCKS—Bernitz Furnace Appliance Co., 89 Broad St., Boston, Mass., has issued Bulletin B-343 describing Bernitz "Acme" silicon-carbide, air-cooled blocks, added to company's line during the year just closed.

INSULATION TESTER—James G. Biddle Co., 1211-13 Arch St., Philadelphia, Pa., has issued Bulletin 1350 describing the new midget "Megger" tester, with range of 0-20 megohms.

ZEOLITE SOFTENERS — Cochrane Corp., 17th St. below Allegheny Ave., Philadelphia, Pa., has issued Bulletin No. 695 on the several systems of water treatment and respective fields of use. Chemistry of softening is set forth, followed by a description of zeolite softener apparatus, an explanation of methods of rating zeolite softeners, and a discussion of single-unit vs. double-unit softeners and their respective advantages and fields of use.

DIESEL LUBRICATION—Tide Water Oil Sales Corp., 17 Battery Place, Dept. P, New York City, has just issued "Modern Lubrication for Diesel Engines," a 48-page, profusely illustrated manual, including charts, tables, operating hints, oil suggestions, etc.

LEFAX DATA—Latest additions to Lefax data include "Care of Elevators," "Oil in Exhaust Steam Reduces Heat Transfer," "Cost and Reliability of the Diesel Engine," "The ABC of Boiler Feed-Water Softening Lime Soda Zeolite" and "Multiple V-Belts." Obtainable from Lefax (Inc.), Philadelphia, Pa.

STAINLESS STEEL—Electro Metallurgical Co., 30 East 42nd St., New York City. A 20-page booklet, "Stainless Steels and Their Uses," lists 300 applications of these steels.

WELDING—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. 20-page illustrated leaflet describing Flex-Arc Welders, known as Arc Welding Data Bulletin No. 16.

PUMPS—Economy Pumping Machinery Co., 3431 West 48th Place, Chicago, Ill., has issued Bulletin 426 covering a two-stage opposed impeller centrifugal pump for water supply in high buildings for municipalities, industrial and process plants and Bulletin No. 427, covering improved non-clogging submerged sewage pumps.

AIR COMPRESSORS—Advantages and new developments in the angle-compound compressor design are featured in this 32-page, 8½x11-in. catalog. Fully illustrated. Adaptation of this particular compressor type for direct motor drive is stressed. Sullivan Machinery Co., 400 North Michigan Ave., Chicago, Ill.

LUBRICATION—The National Carbon Co., Inc., Carbon Sales Division, P.O. Box 400, Cleveland, Ohio, has recently issued three new bulletins covering application of "Gredag" lubricants. Catalog Section G-132 gives complete description of all grades of Gredag lubricants and is a general treatise on lubrication. Catalog G-232 applies specifically to lubrication of outdoor equipment and Catalog Section G-332 covers lubrication of industrial equipment.

ELEVATOR BUCKET WASHERS—The B. F. Goodrich Rubber Co., Akron, Ohio, has issued a 2-page insert on its rubber washers for elevator buckets and its rubber pulley lagging. The company has also issued a 4-page insert for its mechanical goods catalog on "Armorite."

New Plant Construction

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Ark., Paragould—City voted $100,000 bonds, and soon takes bids municipal light and power plant and distribution system, probably will include new concrete, brick building, and diesel engine or steam generating equipment. $160,000-$170,000. W. A. Fuller Co., 2916 Shenandoah Ave., St. Louis, Mo., engrs.

Calif., Alameda—City Council retained Ford, Bacon & Davis, Inc., engrs., 58 Sutter St., San Francisco and 39 Bway., New York, to make further studies for municipal steam-electric or diesel-electric power plant. To exceed $1,000,000. Report to be submitted in March.

D. C., Wash.—Mar. 17, by Treas. Dpt. at office Sup. Archt., Wash., D. C., constructing west extension to steam distribution system of central heating plant, for public buildings.

Ga., Macon—Mar. 14, by Water Comrs., c/o C. I. Williamson, City Hall, addition to water system filtration plant, incl. all necessary pumping equipment, sluice gates, sinks, drain and water supply line, steam supply main, mixing basins, chemical house and appurtenances, c.i. pipe. $35,000. Wiedeman & Singleton, Candler Bldg., Atlanta, engrs.

Ind., Marion—Vet. Bu., Arlington Bldg., Wash., D. C., preparing plans power and heating plant, incl. 4 boilers, at U. S. Veterans Hospital.

Ia., Blanchard—City plans municipal light and power plant. $39,500. H. L. Cory Co., 1033 Redick Tower, Omaha, Neb., engr.

Ia., Rockford—City plans municipal light and power plant. $105,000. H. L. Cory Co., 1033 Redick Tower, Omaha, Neb., engr.

Ia., Sioux City—City making surveys installing pumps, generators and motors at Main Street Pumping Station, West 6th and Main Sts. $20,000. P. Cook, city engr.

Kan., Burlington—City, E. T. Archer & Co., engrs., New England Bldg., Kansas City, Mo., completed report on contemplated municipal light and power plant, incl. power plant building, engine and other equipment to cost $85,000, distribution system $33,000.

Louisiana and Mississippi—Mar. 21, by State Hy. Comn., Baton Rouge, La., superstructure, machinery, power plant of East Pearl River Bridge, St. Tammany Parish, La., and Hancock County, Miss., on New Orleans-Gulf Coast Short Cut. Former bids rejected.

La., Lake Peigneur—Jefferson Lake Oil Co. plans power plant addition. $30,000.

Mich., Allegan—City plans water supply system and city hydro-electric plant. Application to Reconstruction Finance Corp. for loan of $370,000 made. H. McDougall, city engr.

Mich., Beulah—Village retained Francis Eng. Co., engrs., Eddy Bldg., Saginaw, to prepare plans for complete water supply system and mains, incl. pumping station and equipment. $20,000.

Mich., L'Anse — City prepared preliminary plans preparatory to asking Reconstruction Finance Corp. for loan for enlarging present dam and spillway for city hydro-electric plant, incl. earth fill, rein.-con. spillway, with sluice gate and stoplogs. $12,000.

Mich., Lapeer — Municipality plans power plant with distribution system. C. C. Tinker, Lapeer, engr.

Mich., Lincoln Park—City engaged Pate, Hamann & Hirn, engrs., 1610 Washington Blvd., Detroit, to prepare plans for sewage disposal system, incl. sewage pumping station, intercepting sewers. $150,000.

Mich., Traverse City—Traverse City State Hospital, c/o Michigan State Administration Bd., Lansing, plans power plant alterations to hospital. To exceed $50,000.

Mo., St. Charles—Election Mar. 11, $300,000, constructing municipal light and power plant. Russell & Axon, 4903 Delmar Blvd., St. Louis, engrs.

Neb., Sutherland—Special committee of Platte Valley Reservoirs Assn., H. L. Williams, pres., Gothenburg, has submitted report approving engineering feasibility of proposed dam and hydro-electric power plant on South Platte River, near here, together with canal from North Platte River, 3 mi. west of Keystone to Sutherland dam site with syphon under South Platte River and return canal to river to supply present irrigation project. $4,800,000.

N. Y., New York—Third Avenue Railways, 2396 3rd Ave., plans 1 story, 50x60 ft. substation, 2524 Amsterdam Ave. To exceed $35,000 with equipment. E. J. King, 1119 3rd Ave., engr.

N. C., Burlington—Wilson Finishing Co. plans steam power plant for textile mill. To exceed $30,000. H. V. Biberstein, Charlotte, engr.

N. D., Walhalla—City approved construction municipal light and power plant. $25,000 up. May apply for Reconstruction Finance Corp. loan. C. D. Morton, Bismarck, engr.

Pa., Erie—Erie County Electric Co., 12th and French Sts., plans improvements to power plants, sub-stations and transmission lines, etc. $135,000 funds allotted. Private plans.

Va., Danville—City Council and business men plan erecting 3 dams and hydro-electric plant at Meadows of Dan in Patrick Co., and distributing power to towns of Stuart and Martinville. $2,500,000. Applied for Reconstruction Finance Corp. loan. Present power plant will need expenditure of $1,000,000 if it is to be put in condition to carry increasing load.

Va., Richlands—Jewel Ridge Coal Co., G. W. St. Clair, pres., excavation for foundations for power plant, own forces. Total cost $200,000.

Va., Richmond—Virginia Electric & Power Co., J. G. Holtzclaw, pres., 700 East Franklin St., plans improving power plants and new extensions, in Richmond and Petersburg areas, and in Norfolk and North Carolina areas. $1,000,000.

Wash., Seattle—J. D. Ross, supt. lighting, bids in April for construction work at Skagit power site and completing Diablo Power Plant. $1,625,000 loan from Reconstruction Finance Corp. applied for.

P. E. I., Charlottetown—Dpt. P. Wks. revised plans by C. A. Fowler & Co., Capitol Bldg., Halifax, N. S., and soon takes new bids 5 general contracts for Falconwood Mental Hospital buildings, incl. separate power house. J. E. Harris & E. S. Blanchard, Charlottetown, assoc. archts. Former bids rejected.

Equipment Wanted

DIESEL ENGINE, etc.—**Paso Robles, Calif.**—Apr. 3, by L. B. Henry, city clk., furnishing, installing diesel engine, water pumps, 1 electric motor.

GENERATORS—**Louisville, Ky.**—Louisville Water Co., 435 South 3rd St., preparing plans installation 3 new electric generators which is a replacement. Not definitely decided what size these 2 new units will be, however they will replace the present ones, one of which is 200 kw. and the other 75 kw. $32,000. J. Chambers, ch. engr. Water Co., Alvord, Burdick & Howsen Eng. Co., 20 North Wacker Dr., Chicago, Ill., engrs.

PUMP—**Clarkton, Mo.**—City plans 50,000 gal. tank on 125 ft. tower, vertical turbine pump, 12,150 ft. 4 and 6 in. c.i. mains, 17 double nozzle fire hydrants, 8 in. diam. well, 50 ft. deep with 20 ft. brass strainer and pump house. $20,000. W. A. Fuller Co., 2916 Shenandoah Ave., engr. May apply for loan from Reconstruction Finance Corp.

TURBINE—**Omaha, Neb.**—Metropolitan Utilities Co., 18th and Harney Sts., bids about May 1, centrifugal gas booster driven steam turbine with 750,000 cu.ft. per hr. against 2 lb. pressure and 1,000,000 cu.ft. per hr. against 15 lb. pressure. $22,000. C. D. Robinson, 8th and Harney Sts., engr.

GENERATING UNIT—**Sioux Falls, N. D.**—Mar. 20, by City, furnishing, installing 1,200 hp. diesel engine with electric generator, 1,000 kw. hr. capacity. $70,000. Pillsbury Eng. Co., 1200 2nd Ave. S., Minneapolis, Minn., engrs.

GENERATOR, etc.—**Austin, Tex.**—Mar. 13, by City, A. Johnson, mgr., installing new machinery, city water and light plants, bids wanted on one turbo-generator, 7,500 kw. 80% p.f., 11,500 volts, 3 phase, 60 cycles, steam pressure of 450 lb. and 750 degrees, total steam temperature; one 10,000 sq.ft. surface condenser and auxiliaries. W. E. Seaholm, supt. water works. $275,000.

DEEP WELL PUMP—**Fond du Lac, Wis.**—City bids Mar. 17, pump house and deep well pump, Bischoff St. Alvord, Burdick & Howson, 20 North Wacker Dr., Chicago, Ill., engrs.

PUMPING UNIT—**Ottawa, Ont.**—Corporation of City of Ottawa will purchase in spring 1 new pump unit for Queen St. Pumping Station. $35,000.

ELECTRIC BOILER—**Sault Ste. Marie, Ont.**—Abitibi Pulp & Paper Co., Huron St., considering purchase of 9,000 hp. electric boiler.